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CONDUCTION AND
INFILTRATION ANESTHESIA

CONDUCTION AND INFILTRATION ANESTHESIA

BY

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ORAL SURGEON GREENPOINT HOSPITAL; FORMER ORAL SURGEON HOSPITAL DEFORMITIES AND
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AMERICAN DENTAL ASSOCIATION

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FOUNDED 1878
TO PROMOTE
DENTAL ART, SCIENCE
AND LITERATURE

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TO MY PARTNER AND FRIEND,
WHO INSPIRES AND ENCOURAGES
ME TO GREATER THINGS IN LIFE,

MOLLIE WORONOCK NEVIN,

MY WIFE,

THIS VOLUME IS TENDERLY DEDICATED

"Let the eye go before the hand,
and the mind before the eye."

OLIVER WENDELL HOLMES.

PREFACE

After graduating from the New York College of Dentistry in 1907 and entering into the practice of my chosen profession, I soon realized the shortcomings of my knowledge of rendering dental operations painless. Yet, I fully understood how important this is in the successful pursuit of a profession, the very nature of which is to cause pain. Every dental operation is performed on structures innervated by the terminal branches of the sensory nerves, which are conceded to be the most sensitive and most highly responsive to stimulation and pain.

The most popular agent for inducing local anesthesia at that time was a 2% cocain solution carrying strong germicides and antiseptics. It is true that the tissues were rendered insensitive to the operation, but at what cost to the patient! The patient would come to the office to have the aching root or tooth removed, thus expecting to be relieved of his suffering. The bothersome tooth would be removed more or less painlessly, but instead of relief following this operation, there would frequently follow days and sometimes even weeks of agony. The strong solution of cocain was responsible also for very unpleasant toxic disturbances. This led me to look for other agents and other methods to combat pain. I came to comprehend that many factors enter into the successful mastering of the knowledge of anesthesia; such as anatomy, pharmacology and even histology and bacteriology. I also came to realize that we, as dentists, only too often become callous to the suffering of our patients and forget that they are human beings with an easily responsive nervous system. How much courage it has taken for some of them to finally bring themselves to the dental chair! And how grateful and appreciative they are of every effort to allay their apprehension by kind words, gentle manners and a well-developed technique to render the task easier.

I carefully studied all dental and medical literature pertaining to anesthesia. It became almost an obsession with me. I was inspired and benefited by the writings on the subject of such men as Herman Prinz, Reithmuller, Theodore Blum, Guido Fisher, Braun, Shields, Thomas, Allen, Smith, and many others. The labors of these men helped me to master local anesthesia and to simplify my technique.

With the advent of procaine, operators and experimenters became bolder, and from simple injections into the gum tissue, they advanced to intraosseous injections, and finally to that most effective of all, nerve blocking. Yet even with procaine, the pathway of the oral surgeons and others has been strewn with accidents, or at least unpleasant experiences.

Dr. Berger, in his work, "The Principles and Technique of Oral Surgery," writes as follows: "The question is frequently asked whether there is danger in the administration of local anesthetics. This query may be directly answered by stating that there is no danger whatever in the careful and discriminate use of the mildly toxic local anesthetics, such as are obtainable at the present time." And a little later, speaking of his experience with the troubles of other operators, such as broken needles, the introduction of sepsis, etc., he adds: "Upon analyzing these, I find that the source of the trouble is not, as a rule, inherent in the case itself, but in almost every instance is traceable to faulty technique."

With this last sentiment I heartily agree, and it has been in the hope of adequately describing the safest and best technique that the following pages have been written. There has been a great deal of literature treating of this subject, but it seems a fair criticism that what has been presented thus far, has been addressed rather to the graduate, or experienced practitioner, than to the inexperienced. It has therefore seemed both possible and advisable to offer a treatise on this important subject which shall so plainly outline the principles involved, and so clearly describe the technique which accomplishes the desired result with the minimum of danger to the patient, that even the undergraduate student may comprehend and readily make use of this great method of operating without pain.

"Physician, heal thyself!" is a trite old epigram which we might paraphrase by saying, "Dentist, have thine own teeth treated," in which case the dentist-patient would soon learn how much he might ameliorate the sufferings of his fellow men, if he would but master and practice the use of local anesthetics.

The study of this great subject has always been to me a source of joy and relaxation, and if with this book I may even in some degree succeed in increasing the utilization of local anesthesia by lessening the complications of the technique, and if as a further result there will be less pain inflicted, I will feel that the task has been small in proportion to the end gained.

In presenting this volume to the dental profession, I do not wish to lay claim to any special originality, for "there is nothing original in us except original sin." I have tried, though, to extract what appeared to be the best of the technique of each, and to combine it into a technique comprehensible to the average dental practitioner. I have tried to put it in plain language. I have tried to look upon the subject from the point of view of the man who is trying to learn and understand.

Whether I have succeeded or not, is for the present and future members of the dental profession to judge.

I want to take this opportunity to express my appreciation of the valuable suggestions and help of Dr. R. Ottolengui, Dr. H. E. Tompkins and Mr. L. B. Carpenter.

Mendel Nevin.

Brooklyn, N. Y.

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CONDUCTION
AND
INFILTRATION ANESTHESIA

CHAPTER I.

THE BIRTH OF ANESTHESIA.

One of the distinguishing differences between the savage and civilized man is the progress in the art of healing and the elimination of pain. As civilization has progressed, so has medicine, surgery and anesthesia.

From time immemorial the noblest minds have forever striven to alleviate pain for suffering humanity.

Almost with the beginning of the recording of human achievements, we find references to efforts of mankind to devise some means of alleviating suffering.

Homer mentions the anesthetic effect of Nepenthe. Herodotus speaks of the practice of the Scythians of inhaling the vapors of a certain kind of hemp to produce intoxication and to deaden pain. Then again Pliny and Dioscorides allude in their writings to mandragora as a means of lessening sensibility.

In the Third Century we find reference, in an old clinical manuscript, of an attempt to use an anesthetic for surgical operations. A learned physician of that period, by the name of Hoa-tho, rendered his patients unconscious, while operating on them, by giving them some preparation of hemp.

The word "anesthesia" was coined in 1846. It is derived from the Greek "an," without, and "aisthetos," sensation. It was coined by Dr. Oliver Wendell Holmes, who wrote to Dr. Morton, at the height of the bitter controversy that raged among four different contestants for the honor of the discovery of ether: "Everybody wants to have a hand in the great discovery. All I will do is to give you a hint or two as to the names or name to be applied to the state produced and to the agent. The state should, I think, be called anesthesia. The adjective will be anesthetic. Thus we might say the 'state of anesthesia' or 'the anesthetic state.' "

The story of the discovery of the principle of anesthesia is too interesting and the strife and contentions for the honor too intensive and pathetic to let it pass without giving a concise account of the events leading up to and following the discovery.

In August, 1840, Dr. Horace Wells, then a practising dentist in Boston, extracted a difficult lower molar tooth from the mouth of a medical student, by the name of L. P. Brocket. The operation was very painful, the roots had to be taken out separately, and in exasperation at the suffering of his patient, Dr. Wells exclaimed, "There ought to be some method of mitigating such suffering."

The noble mind of Dr. Wells, in common with such minds since the inception of civilization, had been looking for some agent to alleviate suffering during surgical operations. An incident soon after that occurred in his life which led Dr. Wells' fertile mind to the realization of his ambition.

On December 10, 1844, Dr. Wells attended a lecture given by Professor G. O. Colton at Hartford, Connecticut. The lecture was on chemistry. To make it more entertaining, the lecturer invited volunteers from the audience to the stage to inhale "laughing gas," to show the effect it produced upon the system. Dr. Wells was one of the volunteers to inhale the nitrous oxid gas in order to experience its effect. But what particularly impressed the Doctor was that one of the volunteers who had inhaled the gas, in his antics while under its influence, bruised his legs until they were bleeding and yet, when interrogated by Dr. Wells, was entirely unconscious of his injuries. This incident made a deep impression upon Dr. Wells. He logically reasoned that the same gas could be used to advantage to render patients unconscious during the extraction of teeth and thus save them the attending pain.

Once the idea was conceived, he immediately put it into execution. But not wishing to subject any one to possible danger, he arranged to take the gas himself and have one of his own teeth extracted while under its influence. Mr. Colton, the lecturer, administered the gas to Dr. Wells the next day and a tooth was painlessly removed by Dr. Riggs, an associate of Dr. Wells. Thus, through the ingenuity and the searching instinct of this dentist for something to alleviate pain of operation, anesthesia was born on that 11th day of December, 1844.

Nitrous oxid, although at first discredited, proved later to be a boon to humanity, and stimulated further experimentation with other agents and the final discovery of other anesthetics.

The story of this remarkable dentist and the struggles that followed are pathetic in the extreme. About a month later Dr. Wells went to Boston to demonstrate his discovery. He was given an opportunity to demonstrate his anesthetic at the Massachusetts General Hospital. After a lecture to the medical students he administered nitrous oxid to a boy, but the public demonstration was not successful. The patient evinced evidence of pain while the tooth was coming out. Dr. Wells was ignominiously hissed and declared to be a fraud.

Dr. Wells, very much discouraged, returned to Hartford. His faith in nitrous oxid as an anesthetic was not diminished and he continued to experiment with the gas and to administer it to his patients. The medical and dental professions gave little encouragement to his labors. No doubt, the fact that Dr. Wells was an obscure dentist, from a country town, helped to hold his discovery in light regard, and as a result the general use and practical application of nitrous oxid in anesthesia was delayed for many years.

Meanwhile, other claimants to the honor of the discovery of anesthesia had arisen. First among them was Dr. William Thomas Green Morton, the discoverer of ether as a general anesthetic. Dr. Morton was a student of dentistry with Dr. Wells in Boston and later became associated with him in practice. He closely followed Dr. Wells' work with nitrous oxid and assisted him in his unfortunate demonstration at the Massachusetts General Hospital. Dr. Morton, together with others, was convinced that nitrous oxid was of no value as a general anesthetic. He, therefore, turned his attention to other methods, such as hypnotism, et cetera. Together with Dr. Jackson, a chemist and physician, he experimented with a number of substances and finally, at the suggestion of Dr. Jackson, he tried the vapors of sulphuric ether for the extraction of a tooth. The operation was a complete success. A little later, on October 16, 1846, Dr. Morton was given an opportunity to demonstrate his new discovery again at the Massachusetts General Hospital. The demonstration was arranged by the then prominent surgeon, Dr. John C. Warren. The assemblage of physicians and surgeons congregated, attired in their frock coats, as was the custom, to watch skeptically another dentist who proclaimed another discovery to take away the dreadful ordeal of surgery. The operation was for a tumor of the jawbone, performed by Dr. Warren. It was a complete success. The patient awoke from the slumber and exclaimed, "I have felt no pain." Dr. Warren, deeply impressed, turned to the audience and said, "Gentlemen, you have witnessed a miracle; this is no humbug."

On November 7, 1846, Dr. Warren again operated on a patient, anesthetized by Dr. Morton with sulphuric ether. It was an amputation, and the operation was again a complete success. Soon after that, the new discovery rapidly spread all over the civilized world and ether was adopted as an anesthetic by the medical and dental professions.

But nothing under the sun runs smoothly, not even the noble work of alleviating pain. Soon a third claimant arose for the honor of the discovery. This was Dr. Charles T. Jackson, a physician and chemist of Boston, who conducted a chemical laboratory for teaching purposes. It was he, so Dr. Jackson claimed, who suggested ether to Dr. Morton. In a published pamphlet he stated that he used ether as early as the year 1837 to obtain relief from bronchial irritation from chlorin gas; that this caused loss of consciousness and then again awakening. It was Dr. Jackson who helped Dr. Wells with the manufacturing problems of nitrous oxid.

A bitter contest arose between Dr. Wells, Dr. Morton and Dr. Jackson. It appears that Dr. Wells, before the heralded discovery of Dr. Morton, had tried sulphuric ether at the suggestion of a physician by the name of Dr. E. E. Marcey. He came to the conclusion, however, that ether was more dangerous than nitrous oxid and could not see any advantages over the "laughing gas." Evidently Dr. Wells looked upon the subject from the viewpoint of a dentist and not a surgeon.

The differences between Dr. Morton and Dr. Jackson were soon patched up, but again quickly broken. Together, they obtained a patent on ether, disguised it by aromatic oils and called it "Letteon." They then proceeded to sell the rights to dentists and physicians to use it. Dr. Jackson, however, soon withdrew from this combination, fearing criticism, for unprofessional conduct, by the medical society. The bitter feud between Dr. Morton and Dr. Jackson was resumed with renewed vigor. Each one claimed credit for himself, denying the other's claim. Dr. Jackson demanded the profits accrued from selling the rights to the use of ether. A large monetary testimonial from the United States Government and also from England, to the discoverer of anesthesia, could not be awarded on account of the controversy.

At this time, a practitioner in Georgia, Dr. Crawford W. Long, announced that he had performed an operation on a patient while under the influence of sulphuric ether, as early as 1842. He did not, however, proclaim this until 1849, during the height of the controversy. Dr. Long did not press his claim vigorously and did not join the contest. In announcing this discovery he said, "I leave it with an enlightened medical profession to say whether or not my claim to the discovery of anesthesia is forfeited by not being presented earlier, and with the decision which may be made I shall be content."

A year after the discovery of ether as an anesthetic, an English surgeon, Sir James Y. Simpson, demonstrated successfully the anesthetic properties of chloroform. This anesthetic very soon became popular in Europe and supplanted ether.

Dr. Wells died in New York in 1848. The discouragements, the wrangling over the priority of the discovery, and the continual experimentation with various agents with a view of determining their anesthetic value, seemed to have unbalanced his mind and he himself cut the thread of his existence by opening a vein while taking a bath. A few days later a letter came from Paris announcing that the French Academy of Science had conferred upon him the degree of Doctor of Medicine in recognition of his services to humanity in that he was the first to successfully perform a surgical operation without pain. Poor Wells died at the age of 33, broken in body, spirit and mind.

It is pathetic that these three men—Wells, Morton and Jackson—to whom humanity owes so much, received but little recognition during their lives for their labors and achievements. After the death of Wells, the contest between Morton and Jackson was kept up not only until their death, but even by their descendants. Dr. Morton died in 1868, 49 years of age. His premature death was said to be due to the continual wrangling over the discovery. Dr. Jackson died in an asylum. Thus the great discovery of anesthesia by inhalation brought but misfortune to the discoverers.

Now that the din of the battle is long past and the contestants are beyond pain and strife, humanity should forever revere the memory of those men who did so much to mitigate its sufferings. No matter what the motives were that actuated Morton and Jackson, we owe them a debt of gratitude which is impossible to pay. Even if they were guilty of the things accused, even if Dr. Morton's conduct was not entirely ethical, has not he contributed more to the welfare and betterment of the human race than were he strictly ethical and lived and died only as an ethical professional man, without a thought for those unfortunates who were and are daily subjected to surgical operations? We are all more or less actuated by gain, but is it not far nobler, in the chase for fame or material things, to strive to improve the lot of the sufferer, to make his task but a trifle lighter? Any one who has ever in his life undergone a surgical operation, who has experienced that blissful slumber and complete forgetfulness which otherwise would have been excruciating wakeful agony, will fully appreciate the magnitude of indebtedness humanity owes to Wells, Morton, Jackson, Simpson and Long.

The following extract from the New York *Herald,* July 21, 1841, will vividly contrast surgery of to-day with the pre-anesthesia period. It describes the details of an operation:

"A case (represented in the annexed engraving) was an interesting one of white swelling, for which the thigh was to be amputated.

"The patient was a youth of about fifteen, pale, thin, but calm and firm. One professor felt for the femoral artery, had the leg held up for a few moments to insure the saving of blood, the compress part of the tourniquet was placed upon the artery and the leg held up by an assistant.

"The white swelling was fearful—frightful. A little wine was given to the lad; he was pale but resolute; his father supported his head and left hand.

"A second professor took the long glittering knife, felt for the bone, thrust in the knife carefully but rapidly. The boy screamed terribly; the tears went down the father's cheeks. The first cut from the inside was completed, and the bloody blade of the knife issued from the quivering wound, the blood flowed by the pint, the sight was sickening; the screams terrific; the operator calm.

"Again the knife was thrust under the bone, the terrific screaming was renewed; one or two picked up their hats to leave; scream upon scream and again the bloody blade of the knife issued from the wound and was laid aside. The flesh quivered and the boy cried agonizingly.

"The flesh was thrust back with a small piece of wet linen; the divided ends of the quivering muscles were stopped from blood with a sponge; the saw glistened in the hands of the operator, the father turned pale as death; the boy's eyes fastened on the instrument with glazed agony; grate—crush —once, twice, and the useless limb from the toes to the center of the thigh, was quickly dropped into the tub under the table." (Fig. 1.)

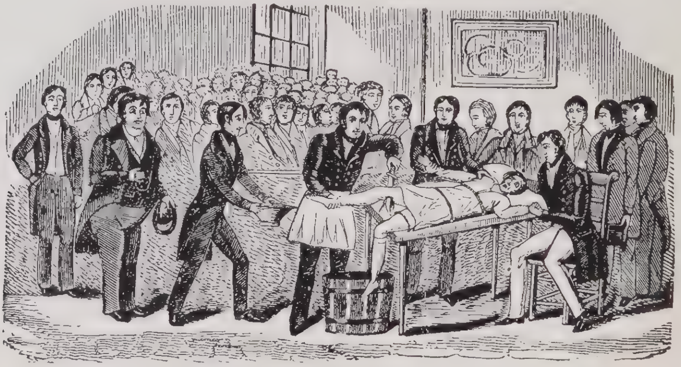


FIG. 1. A surgical operation in pre-anesthesia days.

Thus it appears that one of the great achievements of the human race is so clearly allied with American progress and civilization, that it may be truly termed American. Our brothers abroad may have elaborated on some of its phases, but the United States of America is the cradle of anesthesia, local as well as general.

In 1885, again an American, Dr. Corning, successfully demonstrated that afferent impulses could be blocked by depositing an anesthetizing solution at some point between the periphery and the brain. He was thus the first to introduce spinal anesthesia to take the place of inhalation narcosis.

Following this demonstration, also in 1885, Dr. Halsted of Johns Hopkins University deposited a 4% cocain solution at the mandibular sulcus and produced insensibility in the area innervated by the inferior dental nerve. Thus, it was again an American who introduced nerve blocking injections.

CHAPTER II.

IMPORTANT ANATOMICAL STRUCTURES AND LANDMARKS IN CONDUCTION ANESTHESIA.

The importance of a thorough knowledge of the anatomical structures encountered in nerve blocking injections is quite obvious. It is not sufficient to know only the approximate points of insertion and the direction of the needle. This would be empiricism and would leave the operator at sea in case of complications. The trained anesthetist knows exactly the position and relation of the various structures through which his needle must pass to reach its proper point of destination. This knowledge gives him confidence, which is essential in conduction anesthesia.

This may be metaphorically compared to a traveler arriving in a strange city. He loses all sense of direction. Not having a clear mental picture of the new place, he naturally must make inquiries in order to reach his destination. He timidly wanders about, confused. In his native town, he could go about almost blindfolded. His itinerary is mapped out in his brain beforehand and he crosses confidently from street to street, avoiding the surface cars here, a dangerous curve there, traveling almost subconsciously.

It is not the intention of the writer to confuse the student with too minute a description of the anatomy. He will endeavor to eliminate all the non-essential structures and confine himself to important landmarks; regions we must enter, nerves we must anesthetize, arteries and veins we must avoid and muscles which we should not invade.

The Oral Cavity.

The work of the dental surgeon is confined solely to the oral cavity. Therein his labors are daily performed, no matter what specialty he pursues—whether he be an orthodontist, exodontist, periodontist, prosthodontist, oral surgeon or general practitioner. So that, should he want to construct a plate, regulate an imperfect arch, perform a surgical operation or, as a matter of fact, do any dental work, a thorough knowledge of the anatomy of the oral cavity is essential. This is particularly true for the man who wishes to master the technique of nerve blocking anesthesia.

For the anesthetist, however, the mere knowledge of the structures of the oral cavity is not quite sufficient. While the actual insertions of the needle are made in the oral cavity, the progress of the needle in the various injections is beyond the limits of the mouth proper. We shall, therefore, take up not only the study of the oral cavity, but the adjacent areas where the anesthetist's needle must of necessity travel.

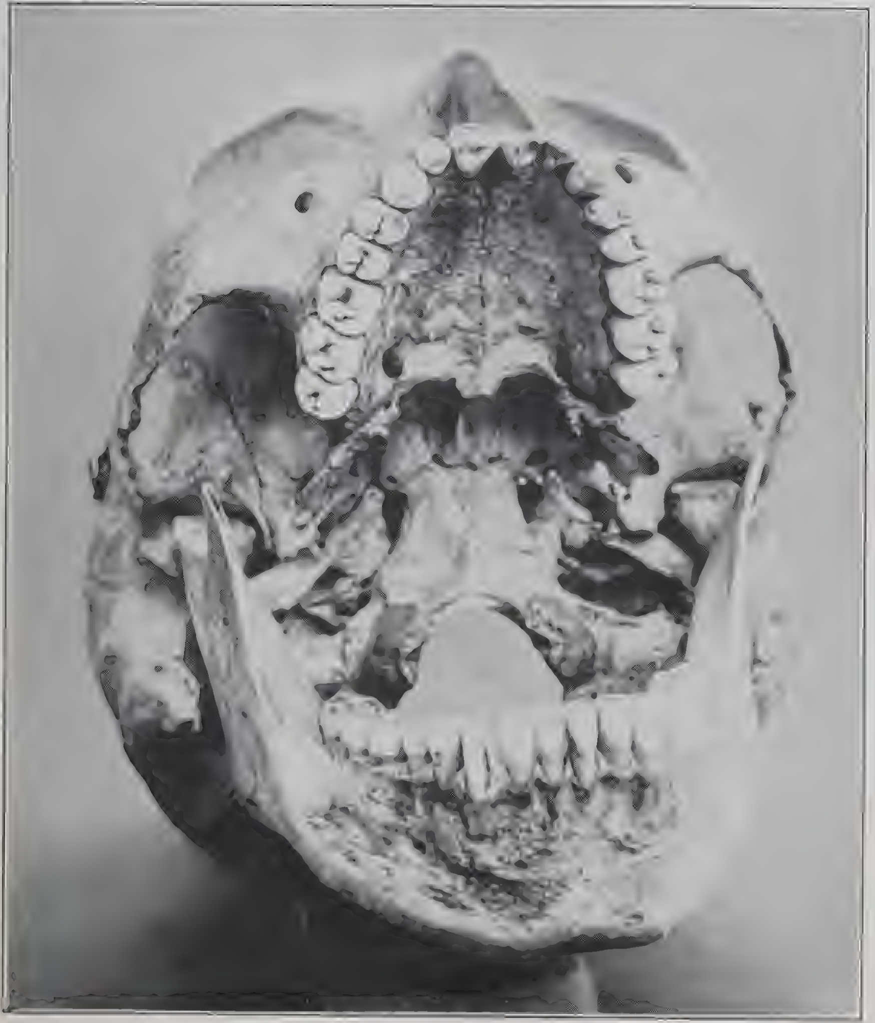


FIG. 2. Framework of oral cavity.

Framework of Oral Cavity.

Just as a house is constructed, first from a framework of wood, iron and bricks and then the coverings and interior such as partitions, plaster, decorations, electric and telephone wires, etc., so does the oral cavity consist of a bony framework. Then muscles and mucous membrane cover this framework and enclose glands, blood vessels and nerves.

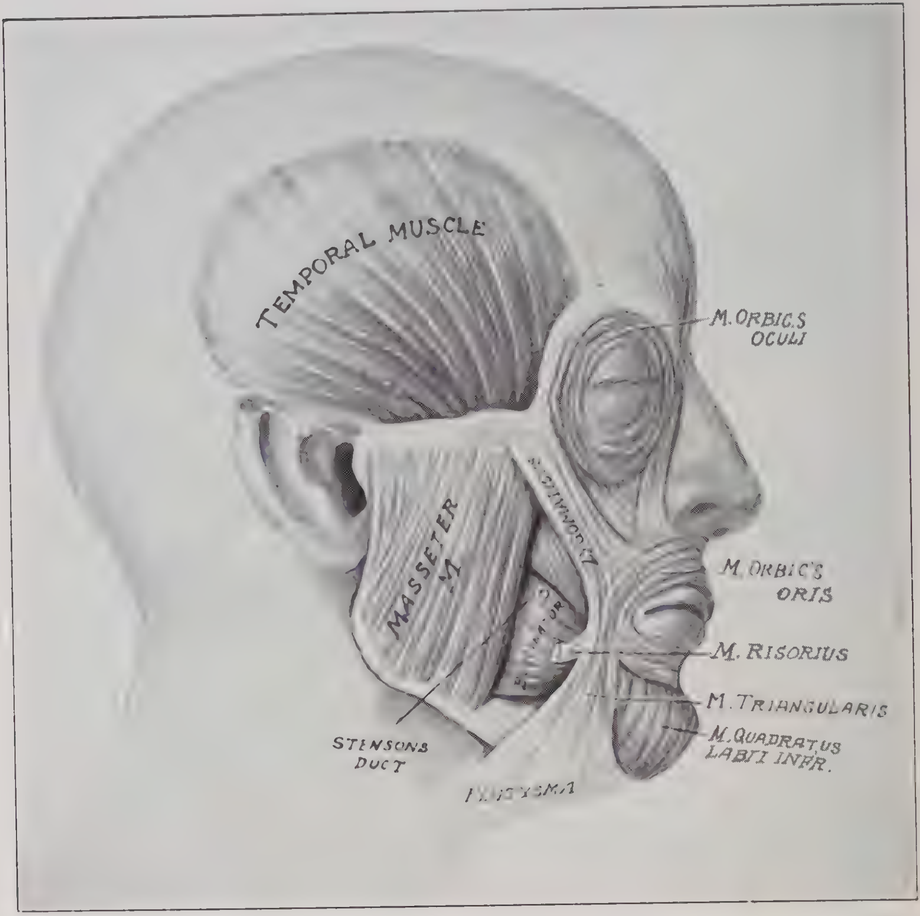

TEMPORAL MUSCLE
M. ORBIC.S OCULI
MASSETER M
M. ORBIC'S ORIS
M. RISORIUS
M. TRIANGULARIS
M. QUADRATUS LABII INFR.
STENSONS DUCT
PLATYSMA

FIG. 3. Muscles of the face and the temporal fossa.

The framework of the oral cavity is formed by the mandible and the hyoid bone below and the palate processes of the superior maxillary bones and the horizontal plates of the two palate bones above. (Fig. 2.)

The oral cavity is divided into two parts, the vestibule (*vestibulum oris*) and the mouth proper (*cavum oris proprium*).

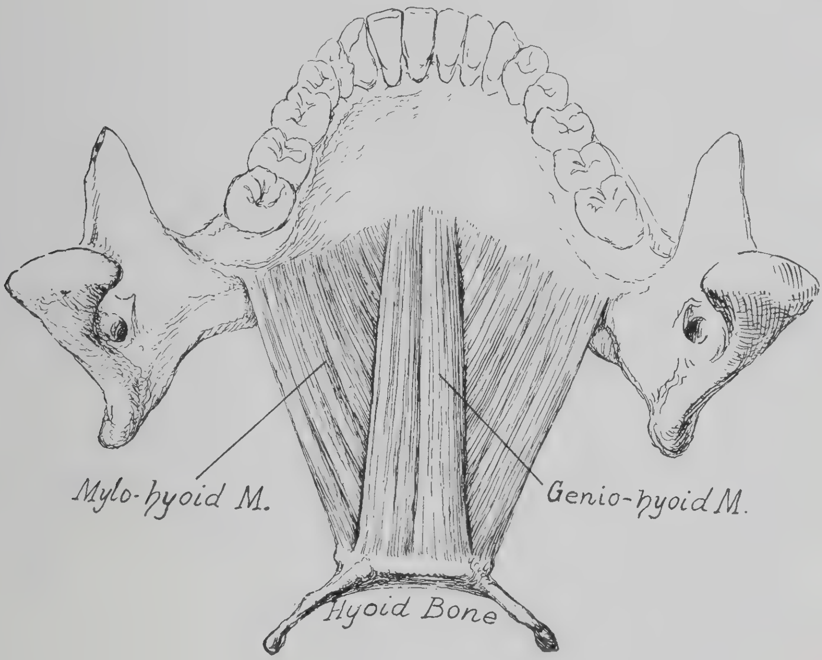


FIG 4. Floor of the oral cavity.

The Vestibule.

The vestibule is that part of the oral cavity located between the lips and cheeks externally and the alveolar ridges and teeth internally. The muscles entering into the formation of the outer boundary of the vestibulum oris are as follows:

The Lips. The orbicularis oris muscle together with some of the fibers of the buccinator and depressor and levator muscles form the substance of the two lips, which by their junction on the sides complete the aperture of the mouth. The contraction and relaxation of the orbicularis oris muscle give the various shapes and expressions to the mouth, such as in smiling, laughing, crying, etc. (Fig. 3.)

The Cheeks. The buccinator and risorius muscles together with the anterior border of the masseter muscle and the temporal ligament form the lateral wall of the vestibule. The cheeks are formed mainly by the buccinator and risorius muscles. The platysma myoides and the zygomaticus muscles also enter into their formation. (Fig. 3.)

Glands Draining Into Vestibule.

Stenson's duct opens into the vestibule draining the saliva from the parotid gland. This duct perforates the buccinator muscle opposite the second upper molar tooth. Besides Stenson's duct, a number of small glands imbedded in various places beneath the mucous membrane of the cheeks and lips, drain their secretions by ducts opening into the vestibule. Most prominent of these are the molar glands, found near Stenson's duct, the buccal glands in the buccinator muscle and the labial glands beneath the mucous membrane of the lips.

The upper and lower boundary of the vestibulum oris is formed by the reflection of the mucous membrane, where it is attached to the alveolar ridges. In front, generally between the two central incisor teeth, there is a mucous fold connecting the lip with the alveolar ridge, above and below. This is the frenulum, the upper being more pronounced than the lower.

In all the nerve blocking injections for the upper teeth and the mental injection on the mandible, the needle is inserted into the reflection of the mucous membrane. The infraorbital, tuberosity, posterior infraorbital and the mental injections are made in the vestibule of the mouth.

Communication of Vestibule with the Mouth Proper.

When the teeth are in articulation and the aperture of the mouth is closed, the vestibulum oris is practically obliterated, the outer muscular wall being in close proximity to the inner bony boundary. The vestibule then communicates with the mouth proper (cavum oris proprium) by a small opening between the last lower molar tooth and the internal oblique line of the ramus. The posterior cusp of the upper last molar tooth closes this opening above. This small opening is frequently resorted to when introducing liquid food into the mouth proper in cases of trismus or complete ankylosis.

The cheeks, resting upon the outer surfaces of the teeth and the tongue against the inner, keep the food between the grinding surfaces of the bicuspids and molars during the mastication of food. In facial paralysis, however, when the motor nerve control is lost, the buccinator and orbicularis oris muscles are relaxed and the food, no longer retained between the masticating surfaces of the teeth, is forced out into the vestibule of the mouth.

Gums.

The lining mucous membrane of the cheeks and lips continues from the mucous fold to be firmly inserted into the alveolar ridges of the maxilla and mandible. It finally surrounds the necks of the teeth and forms the gums in this manner. They are inseparably united to the periosteum. The gums are extremely vascular, but have comparatively few nerve filaments, especially at the reflection of the mucous membrane. This is an advantage in nerve blocking in that the insertion of the needle into the mucous fold is accompanied by slight, if any, sensation of pain.

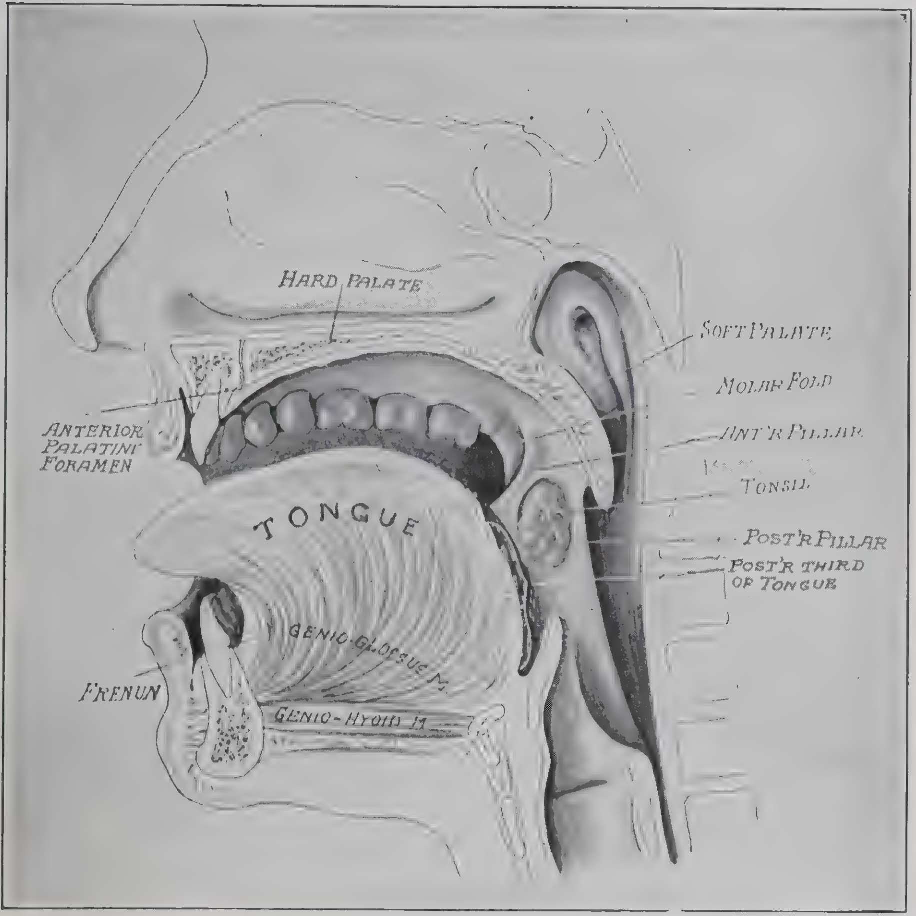

HARD PALATE
SOFT PALATE
MOLAR FOLD
ANT'R PILLAR
ANTERIOR PALATINE FORAMEN
TONSIL
TONGUE
POST'R PILLAR
POST'R THIRD OF TONGUE
GENIO-GLOSSUS M.
FRENUN
GENIO-HYOID M.

FIG. 5. Sagittal section through the middle of the mouth proper and pharynx.

Cavum Oris Proprium.

The mouth proper is that part of the oral cavity which is contained within the dental arches and extends back to the pillars of the fauces.

Floor of the Mouth.

The floor of the mouth proper is formed by the two mylohyoid muscles which arise from the mylohyoid ridges of the inner surface of the body of the mandible, then joining, form a median raphe and extend downward and backward to the hyoid bone. The two geniohyoid muscles strengthen the floor of the oral cavity. (Fig. 4.)

Tongue. The tongue occupies the floor of the oral cavity. It is composed of four intrinsic and four extrinsic muscles on either side. The four intrinsic muscles, two in sagittal and two in transverse planes, form the substance of the tongue.

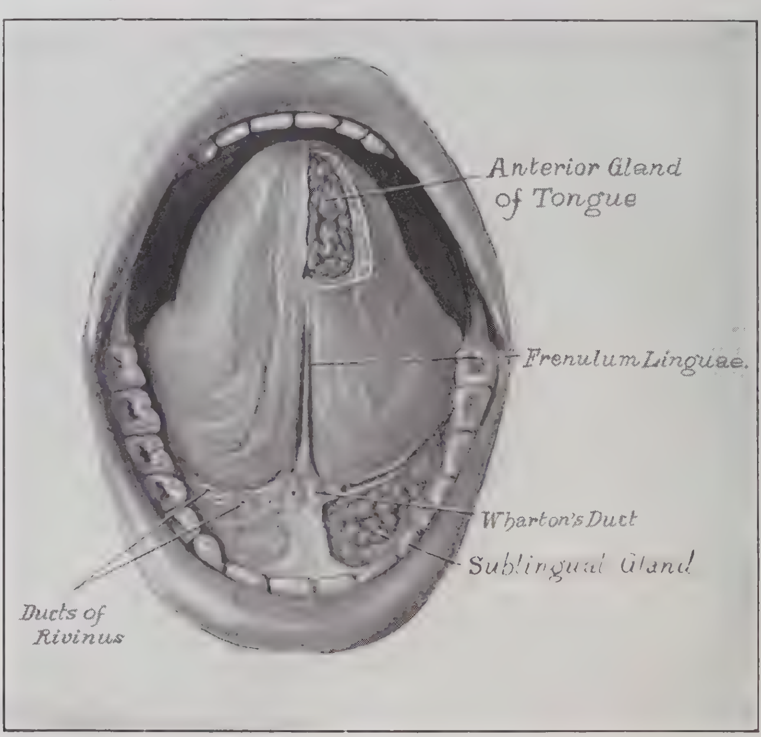


Fig. 6. Under surface of tongue and part of floor of oral cavity, not giving attachment to tongue.

The four intrinsic muscles are united to the floor of the oral cavity by the genioglossus muscle, which runs in a fan shaped manner from the two upper genial tubercles to the hyoid bone and to the under surface of the tongue. (Fig. 5.)

The hyoglossus muscle joins the hyoid bone to the side of the tongue.

The styloglossus muscle connects the styloid process with the under surface of the tongue.

The glossopalatinus muscle, also one of the extrinsic muscles of the tongue, forms the anterior pillars of the fauces.

These four extrinsic muscles help the various movements of the tongue such as elevation, depression, protrusion and retraction.

The upper surface or dorsum of the tongue is strongly convex in its length and not flat as its appearance would indicate. Beginning at the anterior pillars the tongue sweeps downward, assuming almost a vertical position, and forms the anterior boundary of the oral pharynx. (Fig. 5.)

The anterior portion of the upper surface of the tongue is covered with many papillæ containing the special end organs of the nerves of taste.

The inferior surface of the tongue is covered by smooth mucous membrane. A mucous fold runs from the middle of the under surface to the floor of the oral cavity and then to the internal surface of the mandible. This is the frenulum linguæ. (Fig. 6.)

The mucous membrane passes from the under surface of the tongue to the floor of the oral cavity and to the lingual aspect of the mandible where it becomes continuous with the lingual mucous membrane of the lower teeth.

On either side of the frenulum linguæ, on the floor of the mouth, the orifices of Wharton's ducts may be distinctly seen; these ducts carry the saliva from the submaxillary glands into the oral cavity.

Sublingual Glands.

The sublingual glands are situated just below the mucous membrane of the oral cavity, between the tongue and the mandible. These glands drain their secretions by means of a number of small ducts (ducts of Rivinus) which open on the papillæ on the mucous membrane of the floor of the mouth. (Fig. 6.)

Nerve and Blood Supply of Tongue.

The lingual nerve is the sensory nerve supply of the anterior two-thirds of the tongue, the floor of the oral cavity, its lining mucous membrane and lingual mucous membrane of the lower teeth. Its main source of blood supply are the lingual arteries, branches of the external carotid. The sensory nerve supply of the posterior third of the tongue is the glossopharyngeal. The hypoglossal serves as its motor nerve supply.

Roof of Mouth.

The roof of the mouth is formed by the hard and soft palate and separates the nasal fossæ from the oral cavity.

The Hard Palate.

The hard palate is formed by the junction of the two palate processes of the maxillæ and the horizontal plates of the palate bones. It is covered by a thick layer of periosteum, followed by a quantity of dense fibrous tissue and finally mucous membrane. The racemose palatine glands are located in the posterior part of the hard palate imbedded in the dense fibrous tissues.

Innervation and Blood Supply of Hard and Soft Palate.

The two posterior palatine foramina, which are formed by the articulation of the palate bones with the tuberosities of the maxillæ, afford passage for the anterior palatine nerves and the descending palatine arteries. The anterior palatine foramen, formed by the articulation of the two palate processes of the maxillæ, afford passage to the nasopalatine arteries and nerves.

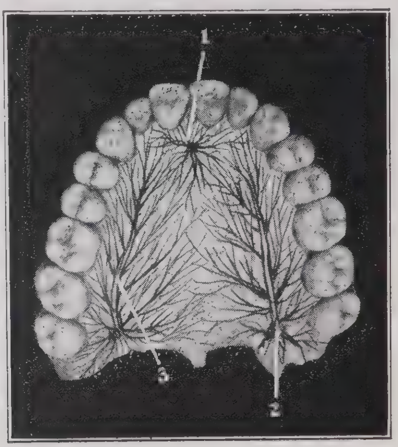


Fig. 7. Bony framework of hard palate. 1. Nasopalatine arteries and nerves. 2. Posterior palatine foramen. 3. Anterior palatine nerve and ascending palatine artery.

The anterior palatine and nasopalatine nerves and the descending palatine and nasopalatine arteries run in a special groove and meet to anastomose in the region of the cuspid tooth. These arteries and nerves supply the soft and hard palate as well as the lingual and palatal alveolar plates, periosteum and mucous membrane of the upper teeth. (Figs. 7 and 8.)

The Soft Palate.

The soft palate is of a fibrous structure and is attached to the posterior border of the hard palate and extends backward into the pharynx, dividing it into the nasopharynx and oropharynx. The soft palate terminates in a conical projection—the uvula.

The soft palate terminates laterally with the anterior and posterior pillars of the fauces which separate the oral cavity from the pharynx. (Figs. 5 and 8.)

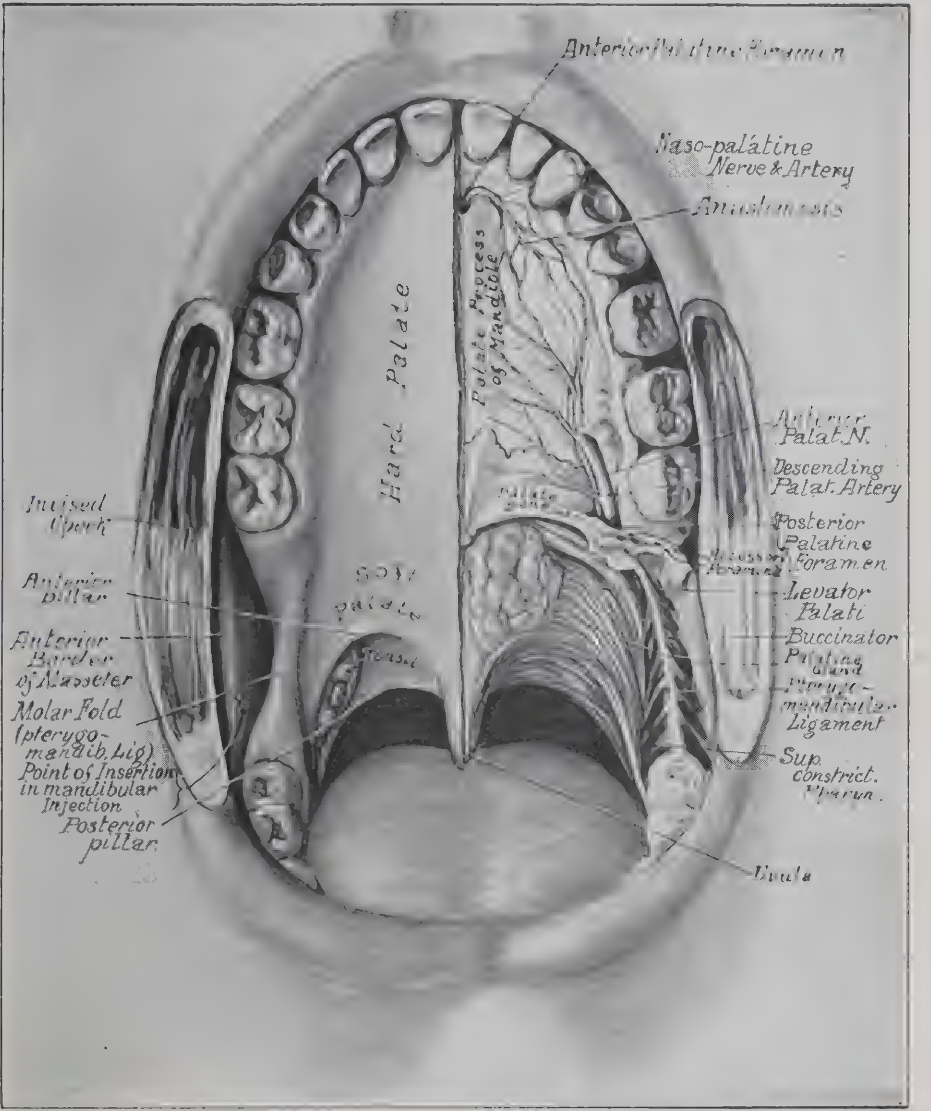

Anterior Palatine Foramen
Naso-palatine Nerve & Artery
Anastomosis
Palate Process of Mandible
Hard Palate
Anterior Palat. N.
Descending Palat. Artery
Posterior Palatine Foramen
Accessory Foramen
Levator Palati
Buccinator
Palatine Gland
Pterygo-mandibular Ligament
Sup. constrict. Pharyn.
Uvula
Incised Cheek
Anterior pillar
Soft palate
Tonsil
Anterior Border of Masseter
Molar Fold (pterygo-mandib. Lig)
Point of Insertion in mandibular Injection
Posterior pillar

FIG. 8. Wide open mouth with cheeks incised looking into pharynx, showing root of oral cavity and fauces. Left side of soft and hard palate is dissected out while the right side remains intact.

Anterior Pillars of the Fauces.

The anterior pillars of the fauces are formed by the glossopalatinus muscle. This muscle, as the name indicates, unites the tongue with the soft palate.

Posterior Pillars of the Fauces.

The posterior pillars of the fauces are formed by the pharyngopalatinus muscle, uniting the pharynx with the palate.

Between the anterior and posterior pillars there is a triangular interval, the sinus tonsillaris, for the lodgment of the palatine tonsils.

The isthmus of the fauces marks the beginning of the pharyngeal cavity. Laterally the tonsils are resting upon the superior constrictor muscle of the pharynx, being separated from the muscle only by a fibrous capsule inclosing the tonsil. Lateral to the superior constrictor is the internal pterygoid muscle. (Figs. 5 and 8.)

Molar Fold.

The buccinator muscle is separated from the superior constrictor of the pharynx by a ligament, the pterygomandibular ligament. Looking into a wide open mouth (Fig. 8) the pterygomandibular ligament appears as a mucous fold, the molar fold, which appears to unite the upper wisdom tooth to the lower wisdom tooth. This fold is deceiving and should be regarded as a villain in disguise. The anesthetist, particularly the beginner, will be tempted to insert his needle when making a mandibular injection into this molar fold, laboring under the impression that by so doing he will be alongside the ramus. However, this is only an illusion as can be seen by comparing both sides of the illustration. Here the villain is exposed and one can see that the needle will pass right into the internal pterygoid muscle and quite a distance from the internal oblique line. How to avoid this and other pitfalls will be described in the chapter dealing with mandibular injection.

Wide Open Mouth.

The anesthetist must carefully study the wide open mouth and be able to distinguish the various structures and their relations.

By placing the finger in the back part of the vestibule of the mouth, opposite and external to the last molar tooth, the anterior border of the masseter muscle and the anterior border of the ramus may be felt, the first one as a muscle band, and the last one as a hard bony ridge, posterior to the former. Further backward and upward the finger will encounter the coronoid process with the temporal muscle attachment. Still further internally and posteriorly the molar fold (pterygomandibular ligament) may be seen and felt. This fold corresponds to the anterior border of the internal pterygoid muscle, which may also be felt with the finger at the same time. Finally, still further back may be seen in the following order: the anterior pillars, tonsils and posterior pillars. Standing in front of a mirror with the mouth wide open the student can locate with his finger and examine these structures in his own mouth and establish their relation clearly in his mind. This will help him greatly in his work.

The mandibular, the anterior and the posterior palatine injections are made within the mouth proper.

The Mandible.

We all have a mental picture of the mandible, and yet many simple points about its structures which would be helpful to us in a mandibular injection entirely escape our attention.

For the purpose of description the mandible is divided into a body and two ascending rami. (Fig. 9.)

External Surface.

Let us consider the outer surface of the body and ascending ramus. It presents to us the following points of interest. (Fig. 10.)

1. The mental foramen, generally situated below and between the apices of the two bicuspid teeth, but slightly posteriorly. Note that the mouth of the foramen opens backward. It is therefore evident that to enter the mental foramen the point of the needle must be directed forward, necessitating forcing the syringe far back, hence making this a rather difficult task.

2. The mental or incisive fossa. This is a depression located to the side of the mental tubercle, between and below the apices of the lateral and cuspid teeth. The fossa has a number of small foramina. The anesthetic solution when injected into or around this fossa will infiltrate readily, entering the cancellous bony structure and anesthetizing the incisive nerve. Thus the alveoli of the six anterior teeth and also their pulps can be anesthetized.

3. The external oblique line. This is a distinct ridge on the external surface of the body of the mandible, continuous above with the anterior border of the ramus. The external oblique line forms the external boundary of the postmolar fossa and is always palpated as a landmark for determining the proper insertion of the needle in a mandibular injection.

4. A depression on the anterior border of the ramus. The remarkable fact about this depression is that when a horizontal line is drawn from its deepest point or its center across the inner surface of the ascending ramus, this line will generally come above the lingula and will cross the mandibular sulcus. This is in accordance with the

investigation and findings of Dr. A. W. Cook at the University of Michigan. In determining the proper height for insertion of the needle in a mandibular injection, this depression is sought and the needle is inserted at the point of its deepest depression, so that when directed on that line, it will reach the mandibular sulcus.

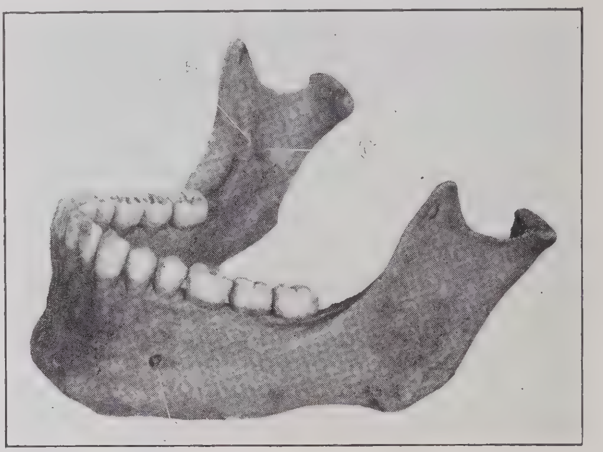


FIG. 9. The mandible. A. External oblique line. B. Internal oblique line. C. Sulcus mandibularis. D. Mental foramen.

5. Area on buccal alveolar plate of molar teeth affording attachment to buccinator muscle. The buccal mucous membrane of the molar teeth is formed by a continuation of the lining mucous membrane of the buccinator muscle.

6. Area affording attachment to the quadratus labii inferioris muscle (*depressor labii inferioris*).

7. Area for the attachment of triangularis muscle (*depressor anguli oris*). These two muscles are just below the mental foramen and it is rather difficult to avoid entering them in a mental injection.

8. Below these two muscles is an area giving attachment to the platysma myoides.

9. Area giving origin to the levator menti muscle. This muscle arises from the incisive fossa.

10. Angle of ramus.

11. Posterior border of ramus. This can be found easily in the patient and the width of the ramus easily determined by placing the index finger in the mouth of the patient on the anterior border or external oblique line, and the thumb on the posterior border of the

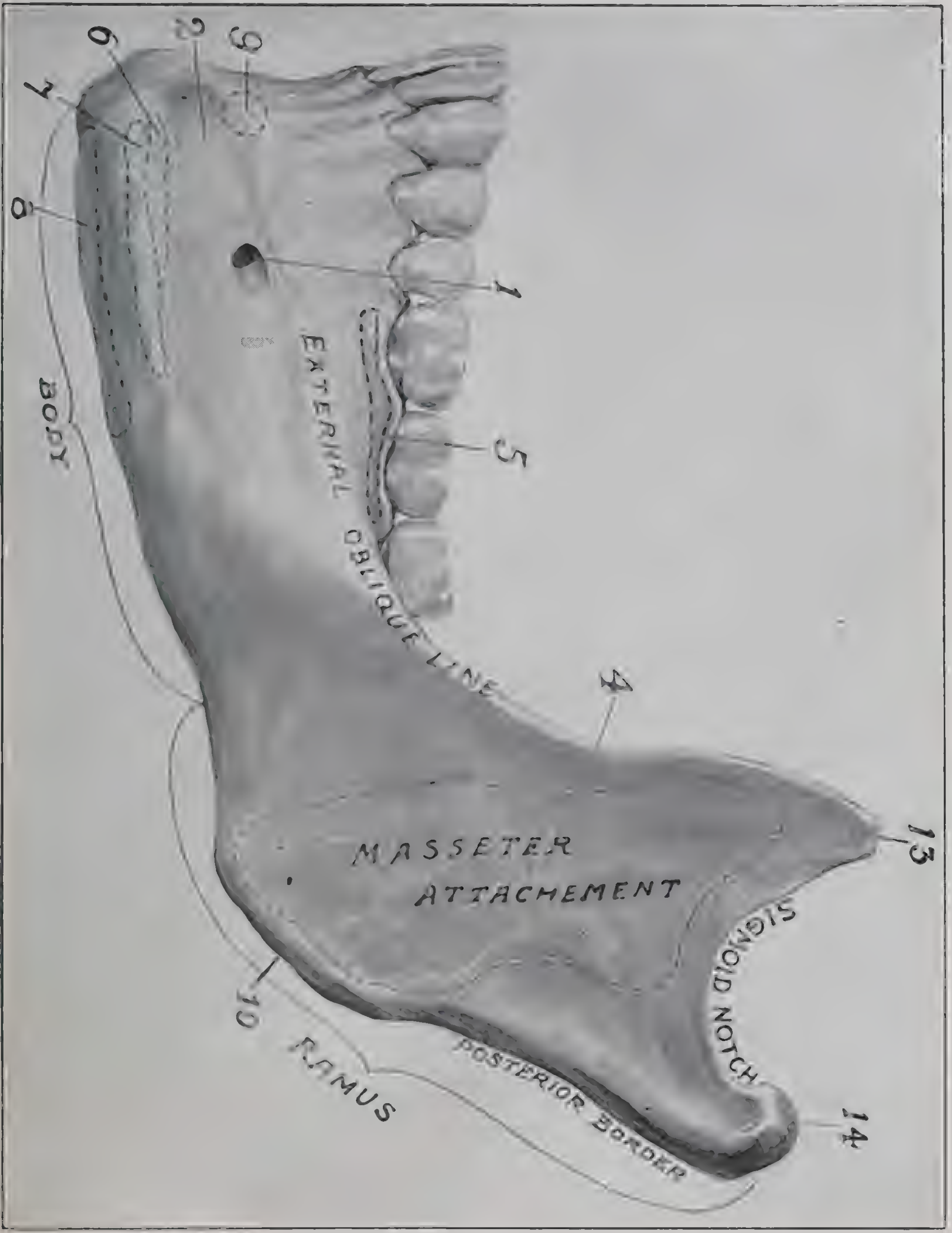

9
2
6
7
8
1
EXTERNAL OBLIQUE LINE
5
BODY
4
MASSETER
ATTACHEMENT
13
SIGMOID NOTCH
10
RAMUS
POSTERIOR BORDER
14

FIG. 10. External surface of mandible.

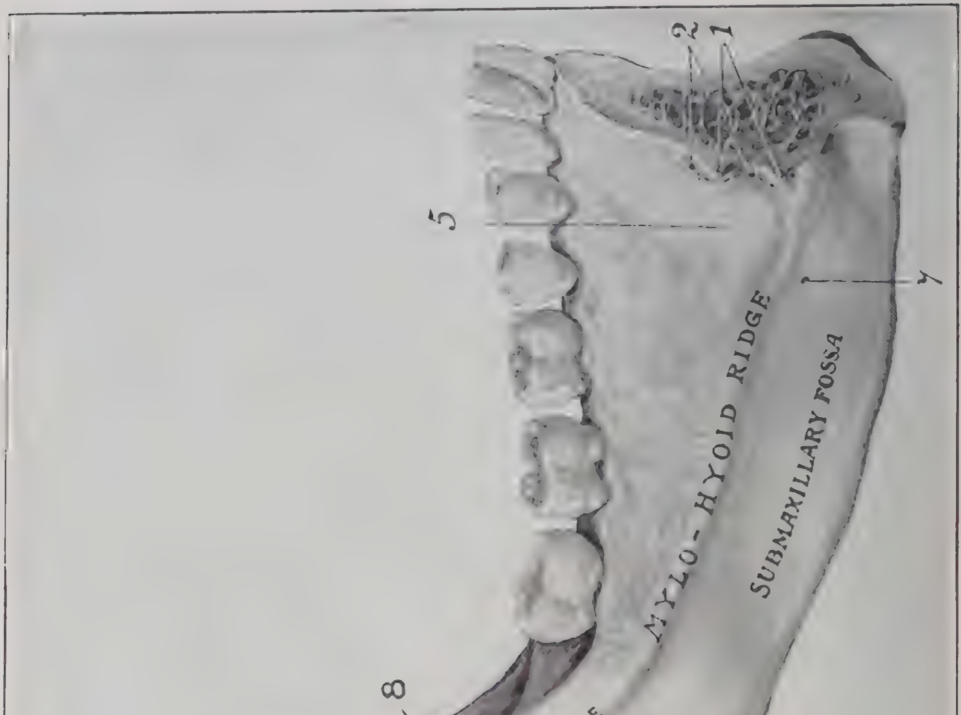

2
1
5
7
MYLO-HYOID RIDGE
SUBMAXILLARY FOSSA
8
INTERNAL OBLIQUE LINE
14
TEMPORAL MUSCLE
16
15
12
10
11
9
13
17

FIG. 11. Internal surface of mandible.

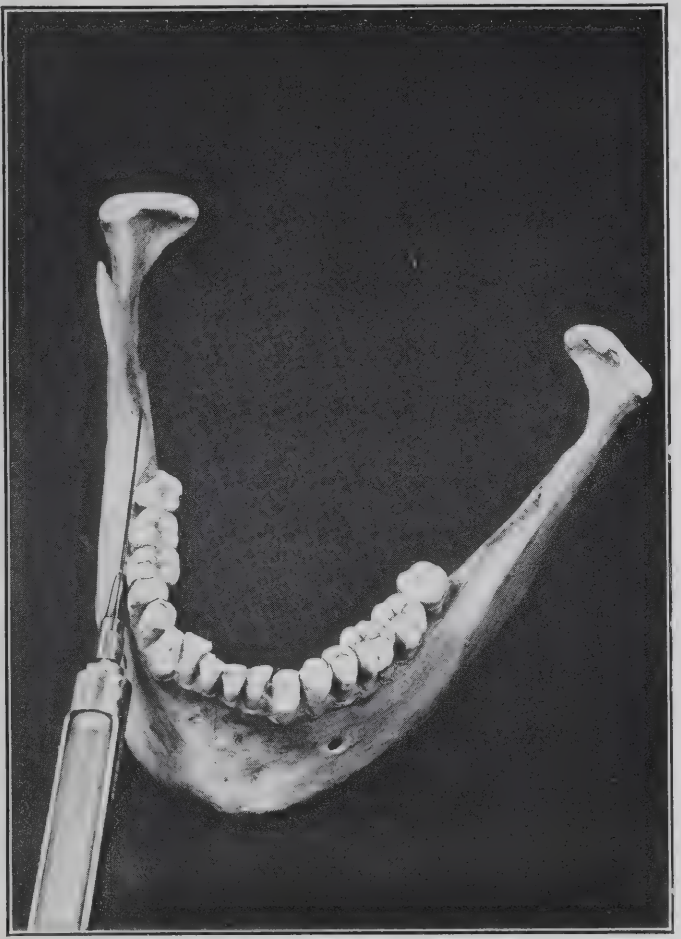


FIG. 12. Internal oblique line is on a horizontal plane with the buccal surfaces of the bicuspid and molar teeth.

ramus. The width of the ramus will enable the anesthetist to determine the approximate length of the insertion of the needle.

12. External surface of ramus, giving attachment to the deep and superficial fibers of the masseter muscle.
13. Coronoid process. The external surface gives attachment to the masseter muscle.
14. Condyloid process. This helps to form the temporomaxillary articulation and fits into the glenoid fossa.
15. The sigmoid notch. This notch separates the two processes, the coronoid and condyloid. By a too high insertion in a

mandibular injection, the needle may pass through the sigmoid notch and enter into the masseter muscle.

The Internal Surface of Body and Ramus.

The internal surface of the mandible presents the following points of special interest. (Fig. 11.)

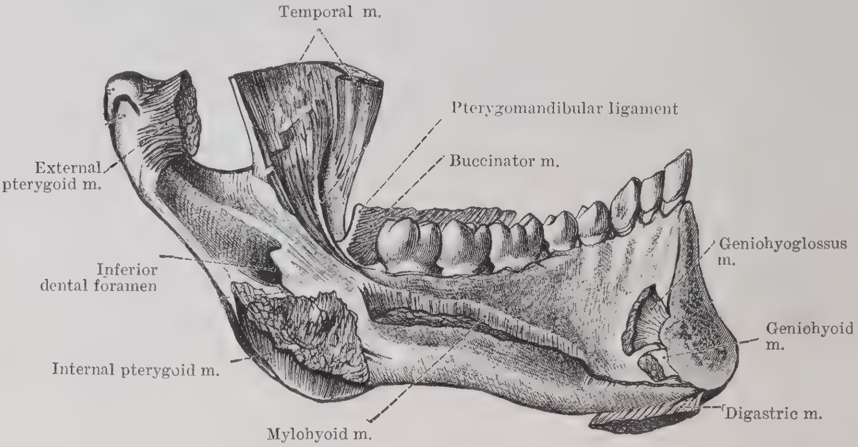

Temporal m.
Pterygomandibular ligament
Buccinator m.
External pterygoid m.
Geniohyoglossus m.
Inferior dental foramen
Geniohyoid m.
Internal pterygoid m.
Digastric m.
Mylohyoid m.

FIG. 13. Attachment of muscles of the inner surface of the mandible. Note especially the attachment of the muscles to the inner surface of the ramus.

1. Genial tubercles. There are two pair of tubercles, the upper pair giving attachment to the genioglossus muscles and the lower pair to the geniohyoid muscles.

The genioglossus muscles extend to the under surface of the tongue in a fan shaped manner and can be distinctly seen in a wide open mouth with the tongue raised. It is continuous with the lower frenulum. (Fig. 5.)

The geniohyoid muscles run from the tubercles to the hyoid bone like two bands and help to strengthen the two mylohyoid muscles forming the floor of the oral cavity.

2. Small foramina on either side of the genial tubercles.
3. Mylohyoid ridge. This ridge gives attachment to the two mylohyoid muscles, which, joining, form floor of the oral cavity.
4. The mylohyoid ridge continues above as the internal oblique line, which forms the inner boundary of the postmolar fossa.
5. Sublingual fossa, a depression above the mylohyoid ridge for the lodgment of the sublingual gland.
6. Submaxillary fossa, a depression below the mylohyoid ridge for the lodgment of the submaxillary gland.

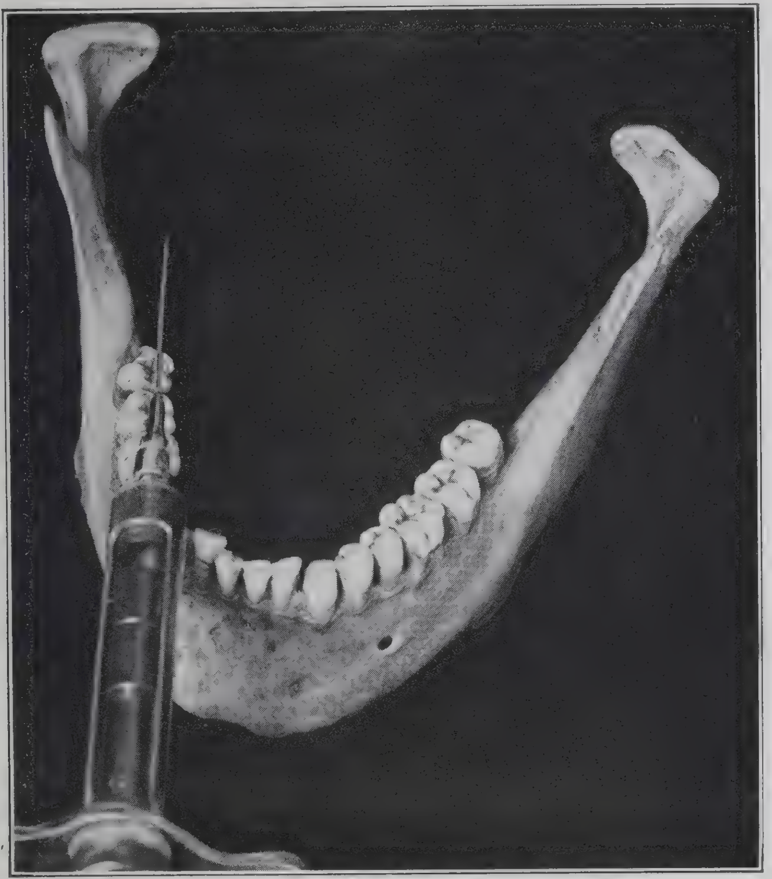


FIG. 14. Needle inserted on a line with the lower molar teeth will be away from ramus for a considerable distance.

7. A small foramen on the inner surface of the body of the mandible corresponding approximately to the mental foramen externally. This foramen is generally more pronounced on one side and sometimes may be indistinct. It is quite possible that a small branch from the cutaneous coli nerve (cervical plexus) may enter this foramen and carry sensation to the mandible. This may sometimes account for the pain during an operation following an apparently successful mandibular injection.

8. Postmolar fossa or triangle. This triangle is formed by the external and internal oblique lines which converge above, to form its apex, while the third molar tooth forms the base of the triangle. Its

name, the postmolar fossa or triangle, does not in reality convey its actual meaning, because the triangle is located not only posteriorly but also distinctly externally to the molar teeth; so much so that the internal boundary of this triangle, or the internal oblique line, is on a plane with the buccal surfaces of the lower bicuspid and molar teeth. In order then to locate the internal oblique line, the needle should be inserted on a line with the buccal surfaces of the lower molar teeth. This point seems to escape the attention of the beginner, who has a mental vision of the ascending ramus to be just posteriorly and on a line with the molar teeth. (Fig. 12.)

9. Inferior dental foramen, situated about the center of the inner surface of the ascending ramus. The inferior dental nerve together with the inferior dental artery and two veins, enter the foramen. These structures are all inclosed in a common fibrous coat, the inferior dental nerve lying in front of the artery.

10. The mandibular sulcus. This is a depression surrounding the inferior dental foramen but extending more superiorly and posteriorly. Into the floor of this sulcus the anesthetic solution should be deposited in a mandibular injection. The depression is present in every case, young or old. The writer has examined several hundred mandibles and as yet has failed to find one without a more or less distinct sulcus. True, in some rare cases it may be shallow, but not sufficiently so as not to enable the operator to find it with his needle.

11. The lingula. This is a projection of bone located at the anterior boundary of the mandibular sulcus and is directed posteriorly. It helps to protect the inferior dental artery and nerve as they enter the inferior dental canal.

12. The posterior wall of the mandibular sulcus. This wall turns inwardly and serves as a landmark in a mandibular injection for the final position of the needle. Examining the topography of the inner surface of the ascending ramus, it becomes evident that when the needle is progressed along this surface, above the lingula, holding the syringe on the teeth on the opposite side, the needle will finally encounter this posterior wall and will serve the operator as a guide, determining the position where the injection should be made in order to deposit the solution into the sulcus.

13. Internal pterygoid tubercle. This tubercle, together with the rough surface above it, serves for the insertion of the internal pterygoid muscle. The muscle is solidly inserted into the lower portion of the inner surface of the ramus as high as the lingula and the inferior dental foramen. In order to avoid this muscle the needle must pass above the lingula.

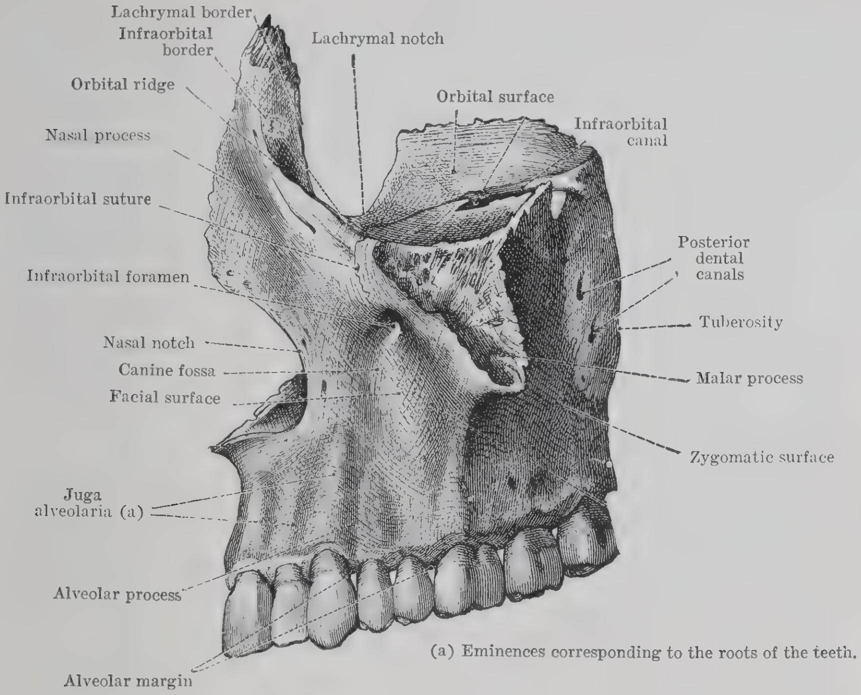

Lachrymal border
Infraorbital border
Lachrymal notch
Orbital ridge
Orbital surface
Infraorbital canal
Nasal process
Infraorbital suture
Posterior dental canals
Infraorbital foramen
Tuberosity
Nasal notch
Canine fossa
Malar process
Facial surface
Zygomatic surface
Juga alveolaria (a)
Alveolar process
(a) Eminences corresponding to the roots of the teeth.
Alveolar margin

FIG. 15. Left superior maxillary bone. (From Toldt's Anatomy.)

14. Coronoid process. The inner surface gives attachment to the temporal tendon.
15. Condyloid process.
16. Neck of condyle. This constricted portion of the condyle affords attachment to the external pterygoid muscle.

Examining the muscle attachments to the inner surface of the ramus, one cannot but be impressed with the fact that the mandibular sulcus and the immediately surrounding area are free from muscle attachment. This fact makes mandibular anesthesia possible, as the injection into a muscle is generally accompanied by edema on account of the slow absorption of the anesthetic solution by the muscle tissue. (Fig. 13.)

Particular attention is called to the fact that the ramus is not continuous in a straight line with the body of the mandible, but joins it at an angle. This angle varies in different individuals, the obtuseness of the angle determining the distance the syringe must be moved to the opposite side in a mandibular injection in order to strike the sulcus mandibularis. Many operators, particularly beginners, will insert their needle just posteriorly to the lower molar teeth, thinking that in this position their needle must

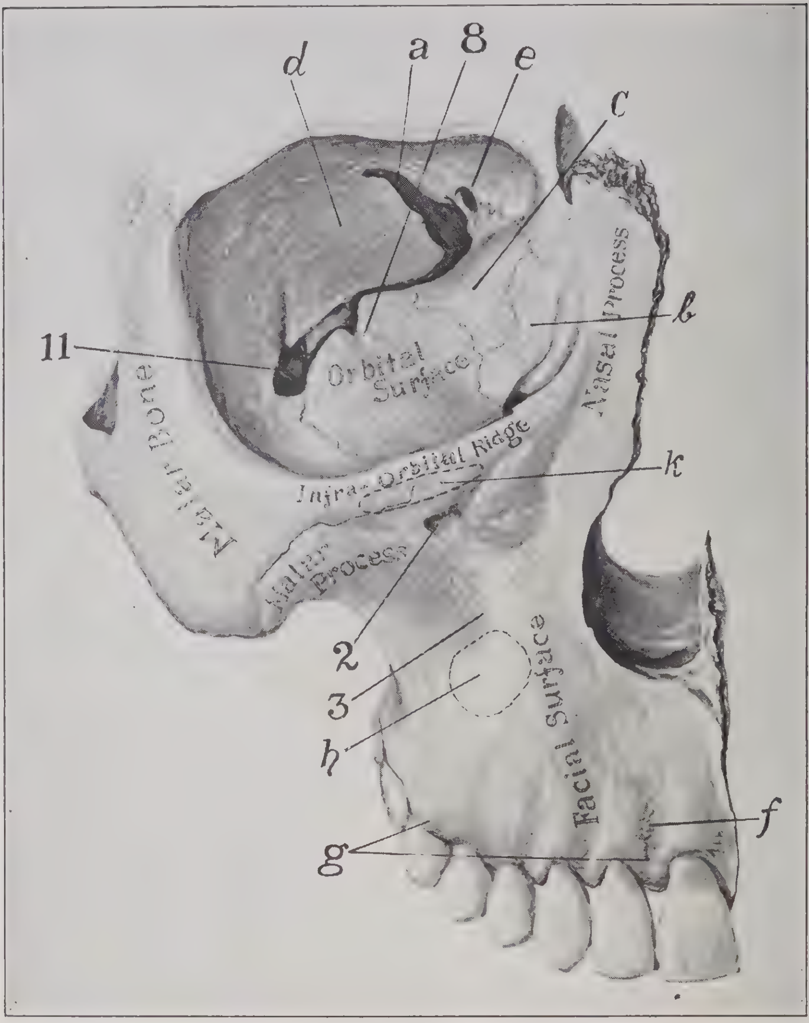

d
a
8
e
c
b
11
Orbital Surface
Nasal Process
Malar Bone
Infra-Orbital Ridge
k
Malar Process
2
3
h
Facial Surface
f
g

FIG. 16. Facial surface of superior maxilla, together with facial bones which enter into the formation of the orbit. A. Sphenoidal fissure. B. Lachrymal bone. C. Ethmoid bone. D. Frontal bone. E. Optic foramen. F. Incisive fossa. G. Alveolar ridge. H. Attachment of caninus muscle. I. Attachment of caput infraorbital muscle.

be alongside the ramus, not realizing that on account of the angle which the ramus forms with the body of the mandible, the needle will be away from bone for a considerable distance. (Fig. 14.)

Superior Maxillary Bone.

Next to the mandible, the superior maxillary bone is of greatest importance to the student in nerve blocking. The second division of the trifacial nerve ramifies through its bony structure, supplying the bone with sensation and also innervating the upper teeth, their alveoli and their investing soft tissues. Five injections are made on this bone at various points, blocking with but one injection either the entire superior maxilla or only certain portions of it. The injections are the anterior infraorbital, posterior infraorbital, tuberosity or zygomatic, incisive or anterior palatine and posterior palatine. It is evident that a thorough knowledge of the structures of the superior maxillary bone is essential. (Fig. 15.)

Of the four surfaces we will describe the following: The facial or anterior, the zygomatic or posterior and the orbital or superior, omitting the internal or nasal.

1. Infraorbital ridge, gives attachment to caput infraorbitale muscle (*levator labii superioris*). (Fig. 16.)

2. Infraorbital foramen, whence the infraorbital nerve and artery emerge from the infraorbital canal to be distributed to the lips, side of nose and eyelid. Note that the infraorbital foramen is on a straight line with the second bicuspid tooth and the center of the orbit. The infraorbital foramen may be located a quarter of an inch below the infraorbital ridge on an imaginary straight line drawn from the pupil of the eye to the long axis of the second bicuspid tooth.

3. Canine fossa, a distinct depression, varying in depth in different individuals, located between the infraorbital and alveolar ridges. The fossa is almost completely filled with the caninus muscle (*levator anguli oris*).

Thus it will be seen that the infraorbital foramen is located between two muscles—the caput infraorbitale and the caninus. Also that in order to avoid the canine fossa in an infraorbital injection and the muscle filling this fossa, the needle must be kept away from bone and directed on the imaginary line before described so as to reach the infraorbital foramen. All these points should be remembered in making an anterior infraorbital injection.

The Posterior or Zygomatic Surface.

This surface is interesting on account of the tuberosity (zygomatic) and the posterior infraorbital (second division) injections. This surface is convex, while the facial surface is concave. (Fig. 17.)

4. The maxillary tuberosity, located at the lower margin of the zygomatic surface. The tuberosity, by its articulation with the palate bone, forms the posterior palatine canal. The tuberosity gives attachment to a few fibers of the external pterygoid muscle. The zygo-

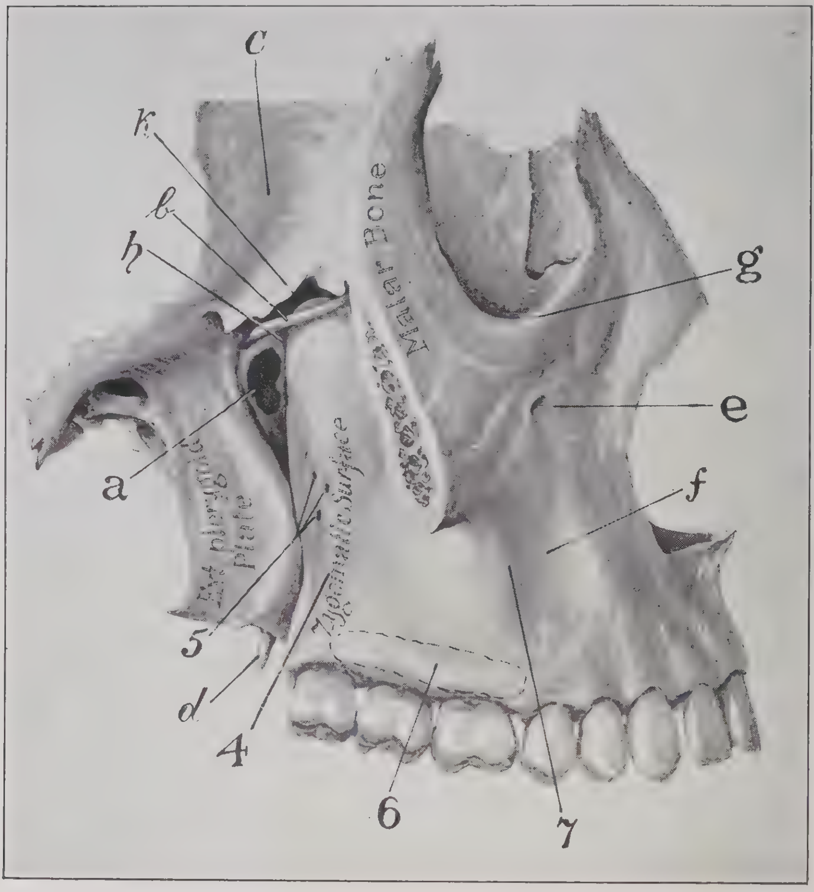


FIG. 17. Posterior surface of superior maxilla showing the infratemporal region and pterygo-palatine fossa. A. Sphenopalatine foramen. B. Superior maxillary nerve. C. Greater wing of sphenoid. D. Hamular process. E. Infraorbital foramen. F. Canine fossa. G. Infraorbital ridge. H. Pterygopalatine fossa. K. Infratemporal crest.

matic surface forms the anterior boundary of the infratemporal (zygomatic) fossa.

5. The posterior superior alveolar foramina, through which the posterior superior alveolar nerves and arteries pass, running in a special canal in the zygomatic surface and supplying the three upper molar teeth. In making a tuberosity injection, the needle is directed toward these foramina and kept in proximity to the tuberosity as much as possible.

6. Area corresponding to the origin of the fibers of the buccinator muscle.

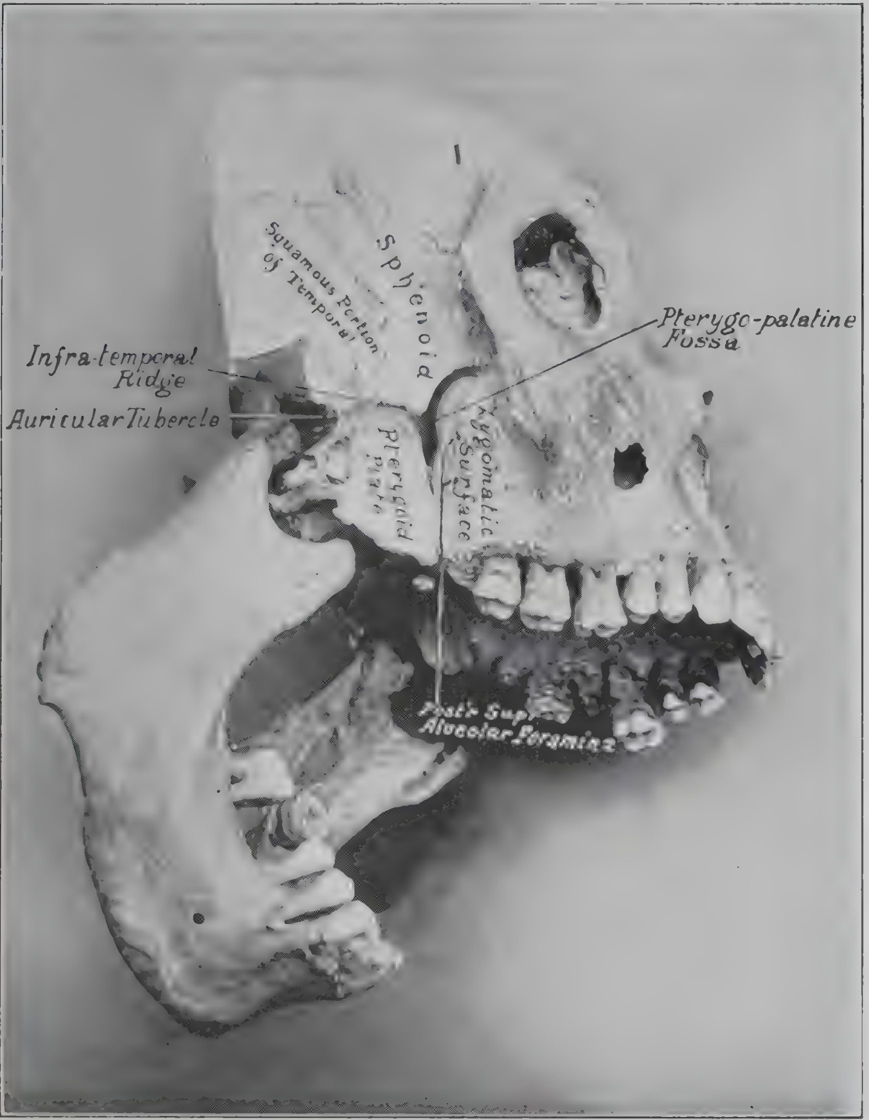

Squamous Portion of Temporal
Sphenoid
Pterygo-palatine Fossa
Infra-temporal Ridge
Auricular Tubercle
Pterygoid Plate
Zygomatic Surface
Post'r Sup'r Alveolar Foramina

FIG. 18. Boundaries of the infratemporal fossa.

The buccinator muscle arises from the buccal alveolar ridge of the upper molar teeth and is inserted into the buccal alveolar ridge of the lower molar teeth. This is an important point to remember in conjunction with buccinator muscle anesthesia. The mucous membrane lining the buccinator muscle forms the buccal mucous membrane of the upper and lower molar teeth. The long buccal nerve, which innervates the buccinator muscle, is also the source of nerve supply of the buccal mucous membrane of the molar teeth, above as well as below.

7. The boundary line between the facial and zygomatic surfaces of the superior maxilla. This is a strong bony ridge extending from the buccal alveolar plate of the second upper molar tooth and blending with the malar process above. This process is an important landmark when making a posterior infraorbital injection. The needle in this injection is advanced along the zygomatic surface of the maxilla. The malar process is palpated in order to clear it with the needle. A good point to remember is that in order to avoid the malar process the needle should be inserted into the reflection of the mucous membrane above and slightly posteriorly to the second molar tooth.

The zygomatic surface terminates above at the sphenomaxillary fissure.

The Orbital Surface.

This surface forms the greater part of the floor of the orbit and is interesting to the student in nerve blocking on account of the infraorbital canal. The anterior infraorbital injection is made at the infraorbital foramen or the anterior termination of the infraorbital canal, while the posterior infraorbital injection is made at the posterior termination of the infraorbital canal. (Fig. 16.)

Points of Prominence.

8. The infraorbital canal. This canal is located just under the floor of the orbit and runs through the orbital surface of the maxilla. The canal often terminates posteriorly in a groove, the infraorbital groove, and anteriorly opens on the face by the infraorbital foramen.

9. About a quarter of an inch posteriorly from the infraorbital foramen a distinct canal is given off which runs downward through the bony structure of the facial surface of the maxilla. This is the anterior superior alveolar canal, lodging the anterior superior alveolar artery and nerve, which supplies the central, lateral and cuspid teeth.

10. Somewhere in the course of the infraorbital canal, its location being inconstant, another canal is given off—the middle

superior alveolar; it contains the middle superior alveolar artery and nerve, which run to supply the bicuspid teeth. (Fig. 32.)

11. The sphenomaxillary fissure. This fissure is formed by the orbital surface of the maxilla below and the greater wing of the sphenoid above. The infraorbital nerve and artery pass through this fissure in order to enter the infraorbital canal. (Fig. 32.)

Two Processes of the Superior Maxilla.

Malar Process.

Of the processes of the superior maxilla, the malar and the palate processes are of interest to us. The malar process separates the facial from the zygomatic surface and is an important landmark in making a posterior infraorbital injection.

Palate Process.

The palate process is a strong horizontally projecting plate of bone. When united, the two palate processes, together with the horizontal plates of the palate bones, form the hard palate and separate the oral from the nasal cavities. They form the roof of the mouth and the floor of the nose. The palate process of the superior maxilla will be here considered together with the horizontal plate of the palate bone. They present two surfaces, the superior and inferior.

Points of Prominence on the Inferior Surface.

1. Numerous foramina for the passage of blood vessels and nerves. These foramina enable the anesthetic solution to be absorbed very quickly, producing anesthesia of the palate, alveolar process of the upper teeth and their investing soft structures. (Figs. 2, 7 and 8.)

2. The anterior palatine foramen. This is formed by four smaller foramina and completed by the articulation of the superior maxillary bones. Two of the small foramina—foramina of Stenson—run laterally, right and left, and transmit the anterior branches of the descending palatine artery. The middle canals, termed foramina of Scarpa, transmit the nasopalatine nerves, the left passing through the front foramen and the right through the posterior foramen. The incisive or anterior palatine injection is made by inserting the needle into the anterior palatine foramen.

3. The posterior palatine foramen. This foramen, as well as the canal, is formed by the articulation of the palate process of the palate bone with the maxillary tuberosity. The anterior palatine nerve and descending palatine artery enter into the oral cavity through this

foramen, passing through the posterior palatine canal. Note the anomaly: the anterior palatine nerve passes through the posterior palatine foramen. Some anatomists, however, call this simply the palatine foramen and, the anterior palatine foramen, the incisive foramen. The posterior palatine injection is made into the posterior palatine foramen. (Fig. 8.)

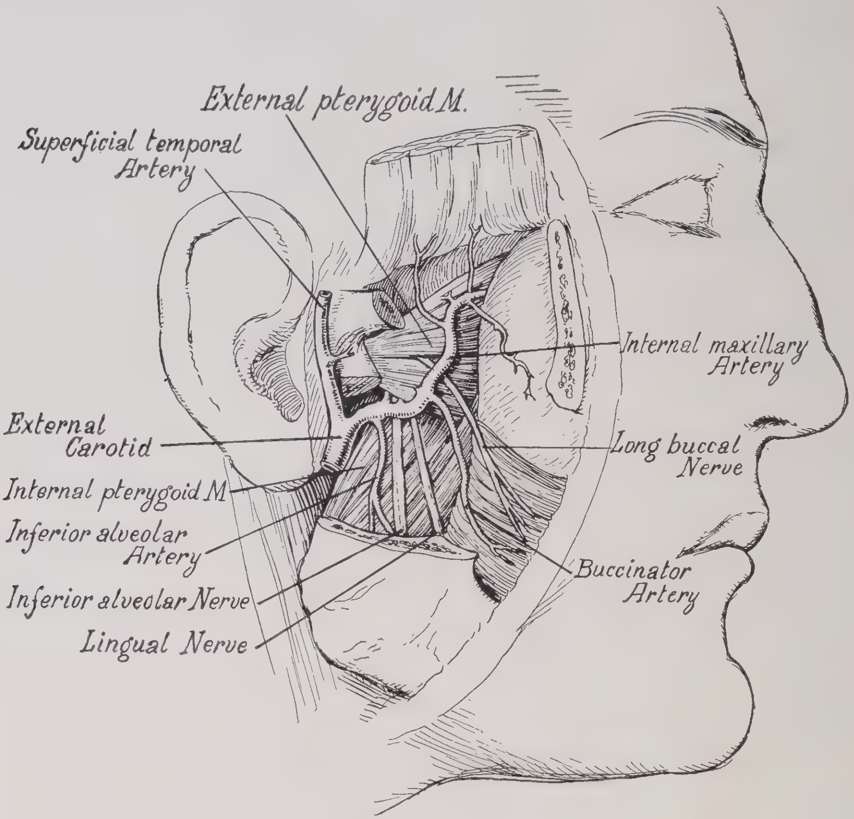

External pterygoid M.
Superficial temporal Artery
Internal maxillary Artery
External Carotid
Long buccal Nerve
Internal pterygoid M
Inferior alveolar Artery
Buccinator Artery
Inferior alveolar Nerve
Lingual Nerve

FIG. 19. Contents of infratemporal fossa.

4. Two accessory foramina (Fig. 8), for the passage of the middle and posterior palatine nerves. For tonsil anesthesia, an injection is made between these two foramina to anesthetize the middle and posterior palatine nerves which supply the upper portion of the tonsils.

5. A groove at the junction of the alveolar and palate processes. This groove gives lodgment to the anterior palatine nerve and descending palatine artery. (Fig. 8.)

Two Important Fossae.

Besides the mandible and superior maxilla, there are two fossæ, a clear understanding of which is essential in order to master the technique of conduction anesthesia. These are the infratemporal (zygomatic) and the sphenomaxillary fossæ.

The Infratemporal Fossa.

This fossa derives its name from the fact that it is located beneath the squamous portion of the temporal bone. It is a very important fossa for the dental surgeon on account of the many important structures which it contains. Everything we do in the oral cavity is to a certain extent reflected in the infratemporal fossa. It is a kind of clearing station or halfway house between the oral cavity and the brain. It contains the source of both the blood and nerve supply of the oral cavity, the gums, teeth and alveoli.

The tuberosity, posterior infraorbital and mandibular injections are made into this fossa. Also the injection into the Gasserian ganglion and the extraoral injections for the superior maxillary and mandibular nerves.

Boundaries of Infratemporal Fossa.

The boundaries of this fossa are as follows (Fig. 18): Anteriorly it is bounded by the zygomatic (posterior) surface of the maxilla, posteriorly by the auricular tubercle of the temporal bone and the spina angularis. The roof is formed by the portion of the greater wing of the sphenoid below the infratemporal crest and also by the squamous portion of the temporal bone. The lateral wall of the external pterygoid plate forms its inner wall, while the ramus, the coronoid process and the zygomatic arch form the outer boundary.

Note the foramen ovale on the roof of the infratemporal fossa. Through this foramen the mandibular nerve (the 3rd division) leaves the cranium to enter the infratemporal fossa on its way to the inferior dental foramen.

Contents of Infratemporal Fossa.

The infratemporal fossa contains the following important structures:

Internal Maxillary Artery.

The internal maxillary artery, which is the reservoir of blood supply for the oral cavity, including the teeth, gums, alveoli, hard and soft palate. The inferior dental artery, a branch of the internal maxillary, supplies all the lower teeth, gums and periosteum. The internal maxillary artery finally enters the infraorbital canal and is then known as the infraorbital artery. Branches from this artery are given off to supply all the upper teeth with blood. Before the infraorbital artery enters the infraorbital canal, the posterior superior alveolar artery is given off, entering the posterior superior alveolar foramen together with the nerve of the same name. This supplies the upper molar teeth, their outer alveolar plate and mucous membrane and periosteum covering this plate. The middle and anterior superior alveolar arteries supply the bicuspid and anterior teeth respectively in the same manner as the nerves supply the teeth with sensation. (Fig. 19.)

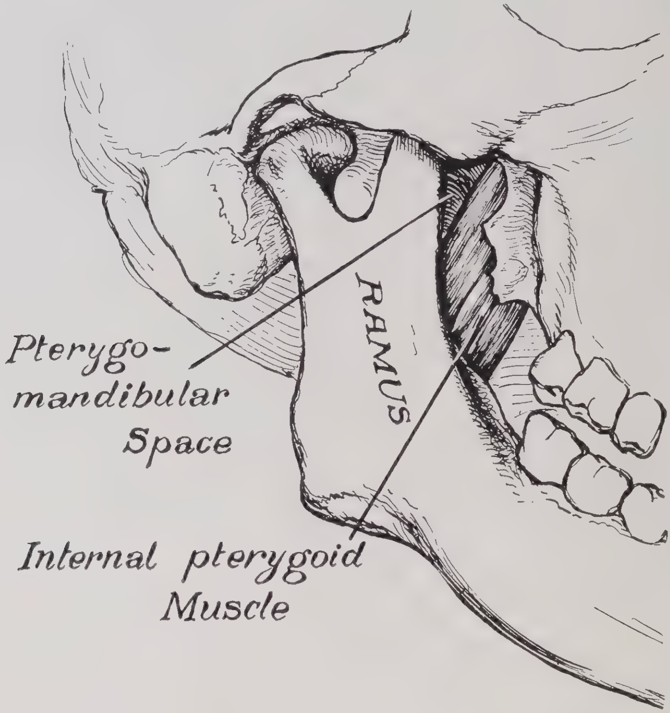


Fig. 20. Pterygomandibular space, formed by the internal pterygoid muscles and the ascending ramus.

External and Internal Pterygoid Muscles.

Two of the five muscles of mastication, the external and internal pterygoid. It is quite important to know the exact origin, insertion and course of these two muscles, as they are easily entered and infiltrated in nerve blocking injections. The internal pterygoid may be entered in a mandibular, while the external pterygoid may be encountered in a tuberosity injection.

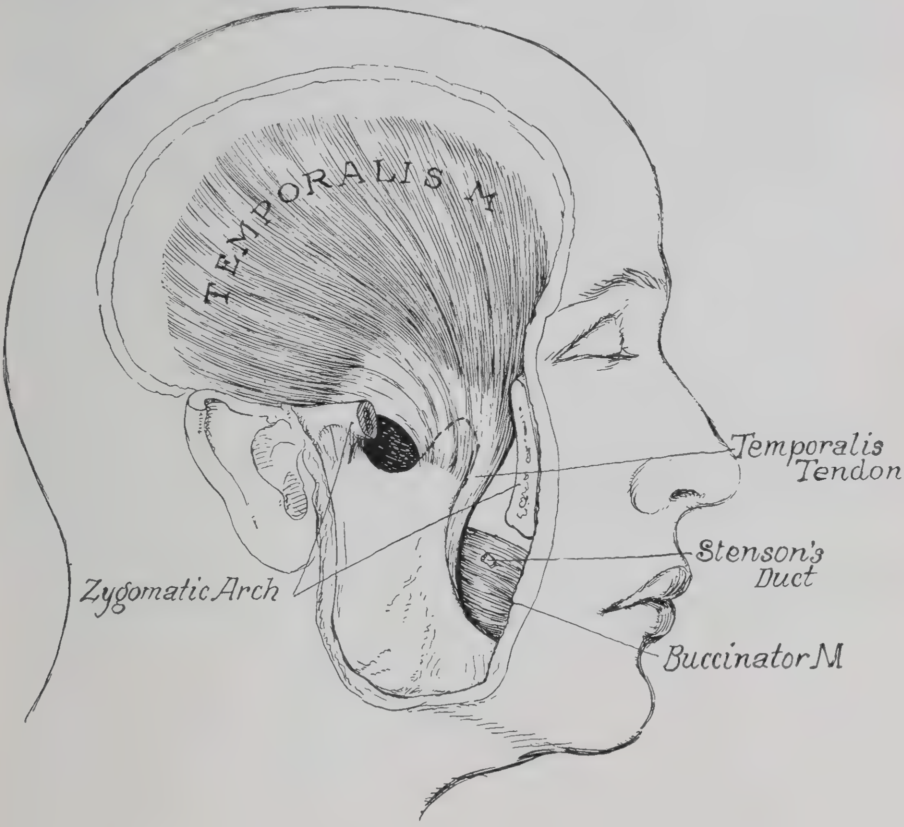


FIG. 21. Origin and insertion of temporal muscle. Note temporal tendon.

Note their relative position. The external pterygoid assumes a horizontal position while the internal pterygoid runs vertically and internally to the former. The two meet almost at right angles. (Fig. 19.)

The internal pterygoid muscle arises from the pterygoid fossa, running downward and backward to be inserted into the internal pterygoid tubercle, and the lower portion of the mandible as high as the inferior dental foramen. Above its insertion the internal pterygoid muscle is away from the ascending ramus, forming a triangular space known as the pterygomandibular space. The space is filled with adipose and areolar tissue and the anesthetic solution when injected will be absorbed rapidly, anesthetizing the inferior dental nerve. In making a mandibular injection, therefore, the student should always bear in mind the position of the internal pterygoid muscle and endeavor to avoid it. The correct technique and how to avoid this muscle will be discussed later in the chapter on mandibular anesthesia. (Fig. 20.)

The external pterygoid muscle arises by a few fibers from the tuberosity of the maxilla, but its bulk arises from the outer surface of the external pterygoid plate, running backward to be inserted into the neck of the condyle. This muscle is often unnecessarily infiltrated in making a tuberosity injection. The muscle can easily be avoided by keeping the needle as much as possible in contact with the zygomatic surface of the maxilla and by not inserting it too far. (Fig. 20.)

Temporal Tendon.

The infratemporal fossa also contains the lower parts of the temporal muscle, particularly its tendon, which is inserted into the internal surface of the coronoid process. This tendon in some cases may be inserted as low as the lower wisdom tooth and frequently offers a great deal of resistance to the insertion of the needle in a mandibular injection. This should not in any manner disconcert the operator, but sufficient force should be exerted to force the needle through this tough tendon. (Fig. 21.)

Nerves of Infratemporal Fossa.

The nerves located in the infratemporal fossa are as follows:

The mandibular (3rd division of the trifacial nerve) and its branches; namely the inferior dental, the lingual, the auriculotemporal and long buccal. (Fig. 19.)

The superior maxillary (2nd division of the trifacial nerve) crosses the infratemporal fossa in order to pass through the sphenomaxillary fissure and enter the infraorbital canal. (Fig. 17.)

Veins of Infratemporal Fossa.

Of the veins in the infratemporal fossa, the pterygoid plexus is of great importance. This plexus of veins covers the outer surface of the internal pterygoid muscle and surrounds the external pterygoid muscle, particularly its inferior border. It drains the venous blood from the oral cavity, gums, pulps of teeth, alveoli, etc. It must be carefully avoided in making a tuberosity injection. By entering the pterygoid plexus of veins with the needle, extensive exudation of blood may take place, resulting in a large, alarming swelling. This condition is known as hematoma, meaning a cavity filled with blood.

Pterygopalatine Fossa.

The other fossa requiring our consideration is the fossa pterygopalatine (sphenomaxillary). This is a narrow, triangular space located just beneath the apex of the orbit, at the junction of the sphenomaxillary and the pterygomaxillary fissures and wedged in between the maxilla in front and the root of the pterygoid process of the sphenoid bone behind. The perpendicular plate of the palate bone forms its internal boundary, separating it from the nasal cavity. It communicates with the nasal cavity, however, by means of the sphenopalatine foramen, affording passage to the nasopalatine nerve. Externally it communicates with the infratemporal fossa by means of the pterygomaxillary fissure. (Figs. 17 and 18.)

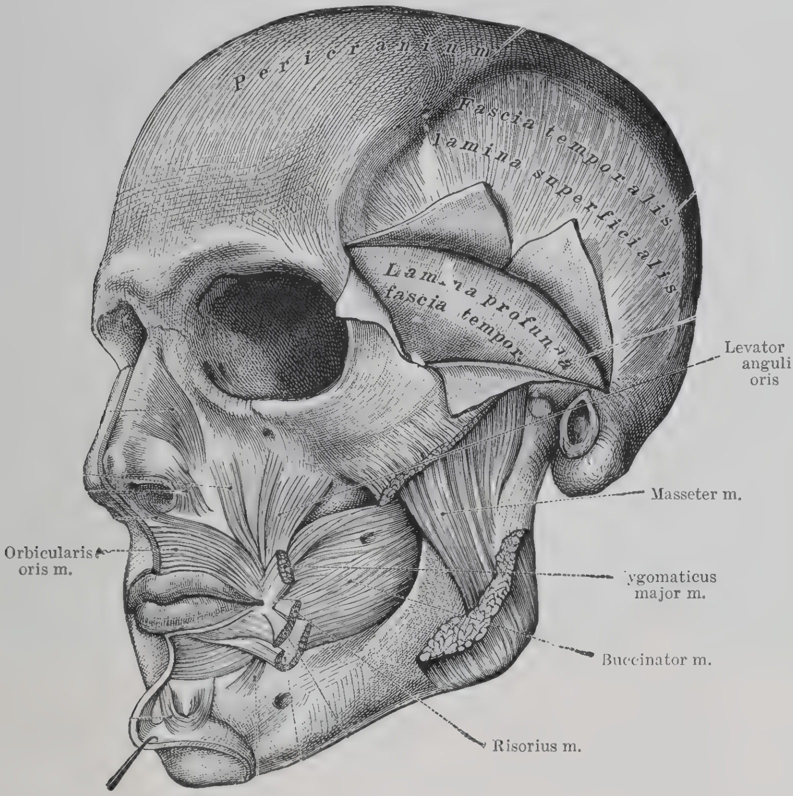

Pericranium
Fascia temporalis
lamina superficialis
Lamina profunda
fascia tempor.
Levator anguli oris
Masseter m.
Orbicularis oris m.
Zygomaticus major m.
Buccinator m.
Risorius m.

FIG. 22. Deep layers of muscles of facial expression. (From Toldt's Anatomy.)

Prominent Points in the Pterygopalatine Fossa.

Remember the following points of prominence in the fossa:

Foramen rotundum by means of which the superior maxillary nerve leaves the cranium and then crosses the pterygopalatine fossa to reach the infraorbital groove.

The opening of the pterygopalatine canal and also the accessory pala-

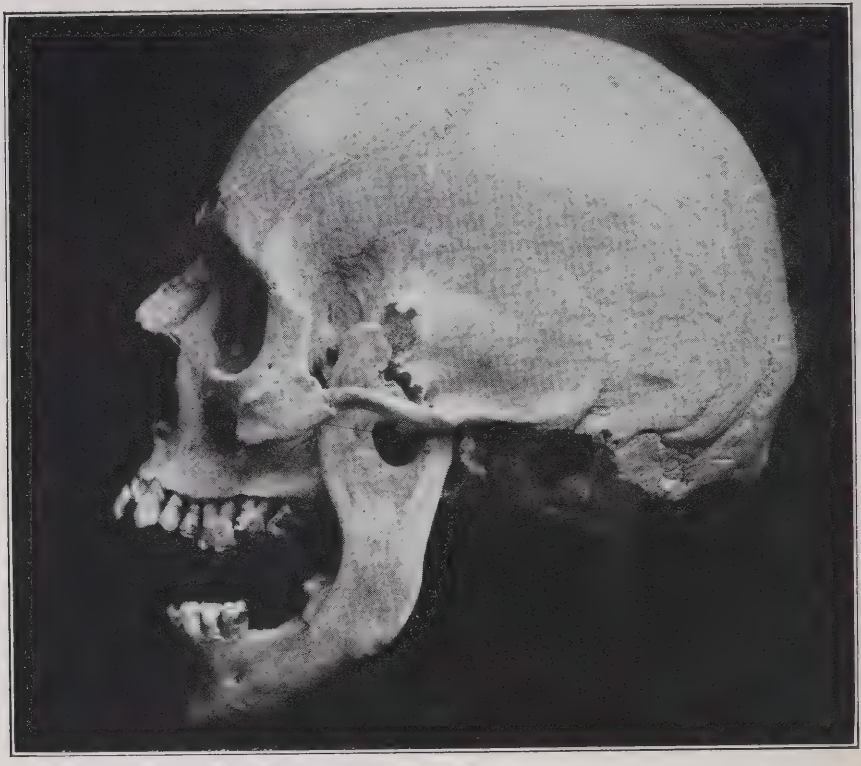


FIG. 23. Ossification of temporal tendon. (From the collection of the author.)

tine foramina for the passage of the anterior, middle and posterior palatine nerves.

Contents of Pterygopalatine Fossa.

The fossa contains:

1. Superior maxillary nerve as it crosses the fossa to enter the infraorbital groove.
2. Meckel's ganglion, from which the inner nerve loop is derived.
3. The termination of the internal maxillary artery.
4. Part of the pterygoid plexus of veins.

Pterygopalatine Fossa to Be Avoided. In conduction anesthesia for dental purposes, the pterygopalatine fossa is seldom, if ever, entered. The extremely narrow space wherein the internal maxillary artery and veins are located, makes the entrance of the needle into this fossa inadvisable. Meckel's ganglion is generally anesthetized in a posterior infraorbital injection by diffusion of the procaine solution.

Sometimes the ganglion may be anesthetized by an anterior infraorbital injection. The anesthetic solution in this case must travel through the infraorbital canal to reach the pterygopalatine fossa.

Muscles of Mastication.

The muscles of mastication play an important part in nerve blocking. The successful mastering of the technique of conduction anesthesia is very difficult, to say the least, without a clear understanding of the distribution of these muscles, their origin, insertion and their functions. The importance of these muscles is not confined only to local anesthesia. In taking impressions or bites, in the adaptation and construction of partial or full dentures, these muscles come into play and exert their influence. The very opening and closing of the mouth and the lateral movement of the lower jaw is largely dependent upon the action, contraction and relaxation of these muscles.

There are five muscles of mastication. The masseter, temporal, buccinator, external pterygoid and internal pterygoid. We have touched upon some of these muscles in our description of the infratemporal region and the mandible. But for a clearer understanding and in order to impress the student more forcefully, we shall take them up now, layer by layer, as though we were back again in the dissecting room.

By removing the skin, subcutaneous tissue and fascia from the lateral aspect of the head, three muscles of mastication come into view (Figs. 3 and 22), the temporal, the masseter, and the buccinator.

The Temporal Muscle.

As the name indicates, the temporal muscle arises from the entire temporal fossa in a fan shaped manner, its fibers merge together to form the temporal tendon, which is inserted into the inner surface of the coronoid process. We have already touched upon the importance of this tendon in mandibular anesthesia in our description of the contents of the infratemporal region. (Figs. 2 and 21.)

Fig. 23 is a remarkable specimen showing complete ossification of the temporal tendon and part of the temporal muscle. In life there was a complete and permanent fixation of the mandible to the squamous portion of the temporal bone resulting in permanent ankylosis. The history of this case would indeed be very interesting, but unfortunately is unobtainable. Examination shows fractured nasal bone on the same side and also a battered zygomatic arch. It is quite possible that ossification of the temporal tendon may have been induced by trauma either from a fistic encounter, a fall or some injury.

The Masseter Muscle. The masseter muscle arises from the zygomatic arch in two sets of fibers, superficial and deep. The superficial fibers arise from the anterior two-thirds of the zygomatic arch and extend downward and backward to be inserted into the angle of the mandible and the lower portion of the outer surface of the ramus. The deep fibers arise from the posterior third of the zygomatic arch and extend downward and forward to be inserted into the upper portion of the outer surface of the ramus and also the outer surface of the coronoid process. (Figs. 3 and 22.)

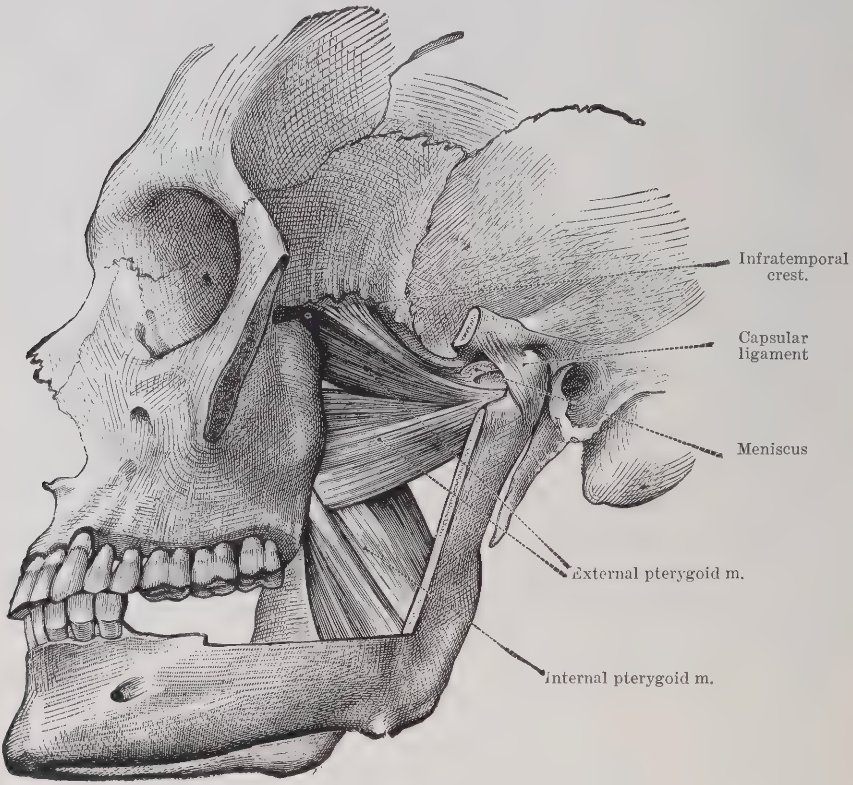


FIG. 24. External and internal pterygoid muscles. (From Toldt's Anatomy.)

This muscle is sometimes unnecessarily entered in a mandibular injection. When the needle is inserted too high it may pass through the sigmoid notch and the solution may be deposited into the muscle tissue.

The Buccinator Muscle. The buccinator muscle, with the help of the orbicularis oris and risorius muscles, forms the greater portion of the cheek substance. It arises from the buccal alveolar plate of the upper molar teeth and is inserted into the buccal alveolar plate of the lower molar teeth. The mucous membrane lining this muscle forms the buccal mucous membrane of the upper and lower molar teeth. This is an important point for the student to remember, because, in studying the trifacial nerve, he will see that the buccinator muscle has a distinct sensory nerve supply, namely, the long buccal nerve. This nerve not only supplies the buccinator muscle but also

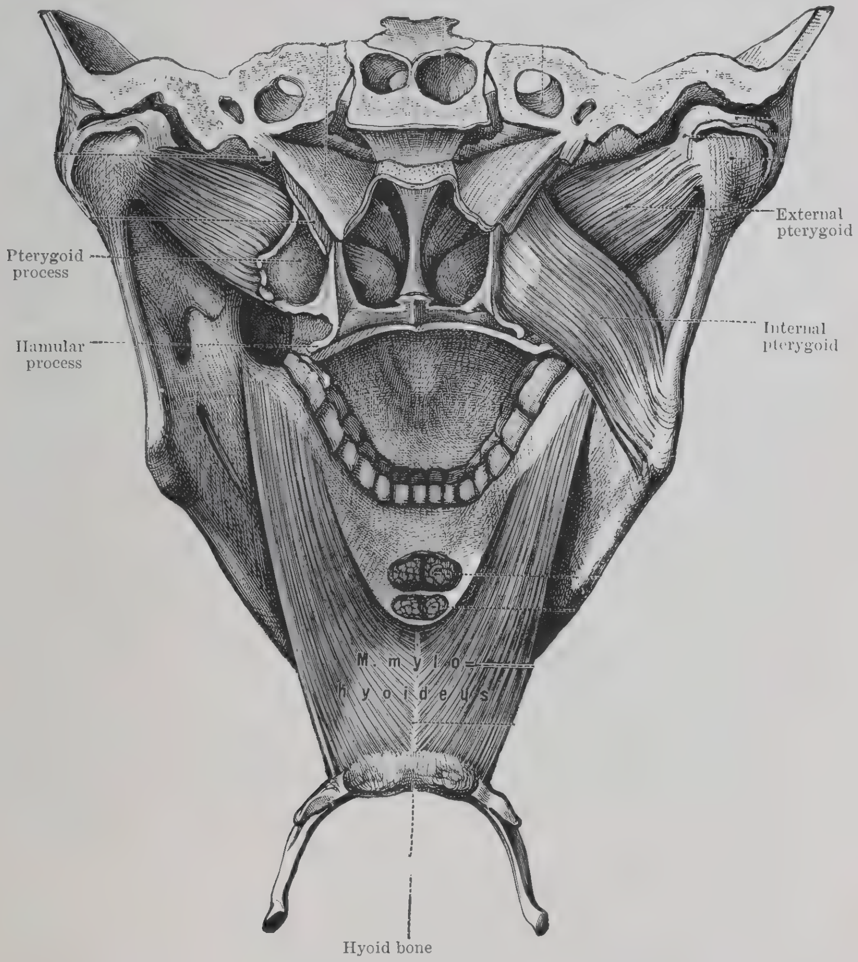

External pterygoid
Pterygoid process
Internal pterygoid
Hamular process
M. mylo-hyoideus
Hyoid bone

Fig. 25. A view from behind of the floor of the oral cavity and the external and internal pterygoid muscles. Both muscles are intact on the right side, while on the left side the internal pterygoid muscle has been removed in order to expose the posterior surface of the external pterygoid muscle. Note the pterygomandibular space. (From Toldt's Anatomy.)

its lining mucous membrane and consequently the buccal mucous membrane of the upper and lower molar teeth. (Figs. 3 and 22.)

Note the duct of Stenson which drains the saliva from the parotid gland. The duct perforates the buccinator muscle, the orifice opens into the vestibule of the mouth in the neighborhood of the upper second molar tooth. Care must be taken not to enter the duct of Stenson in a buccinator muscle injection and not to injure it in a difficult extraction of an upper second molar tooth.

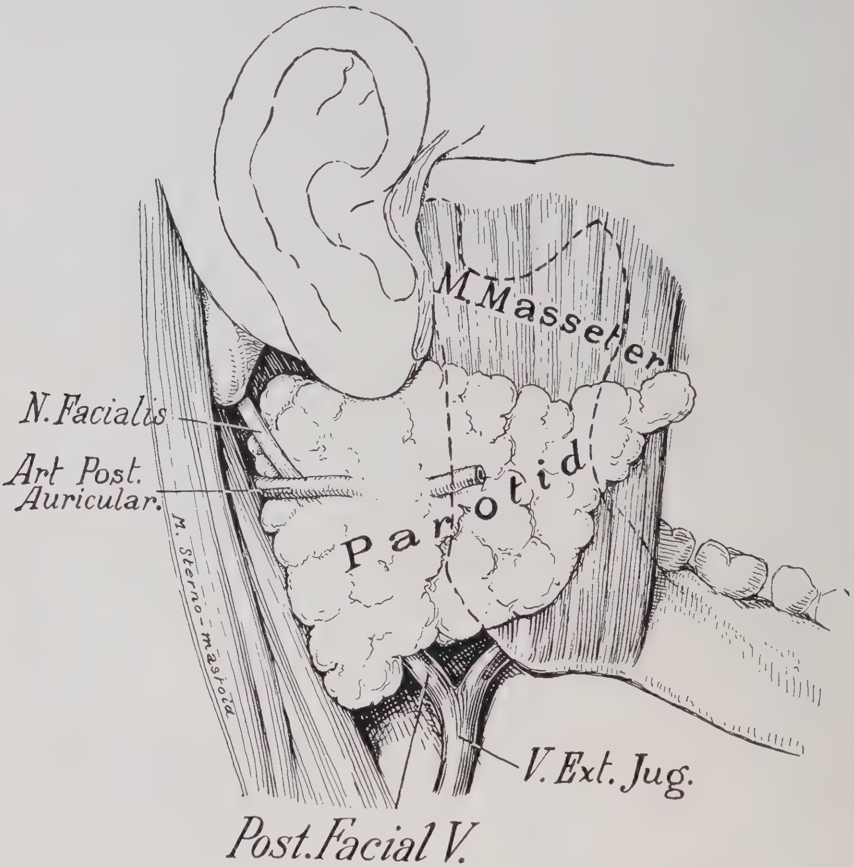

M. Masseter
N. Facialis
Art Post. Auricular.
M. Sterno-mastoid
Parotid
V. Ext. Jug.
Post. Facial V.

Fig. 26. The parotid gland and the structures embedded therein.

External and Internal Pterygoid Muscles.

We now remove the masseter muscle, the zygomatic arch, a portion of the upper part of the ramus including the coronoid process, but leave the condyle intact, and we are once more looking into the infratemporal fossa. Note here the external and internal pterygoid muscles. These two muscles, their origin, insertion and distribution have been fully described in the pages dealing with the contents of the infratemporal fossa. The student is urgently requested again to visualize the position of these two important muscles, as they are of great importance in nerve blocking injections. He must always bear in mind that the internal pterygoid muscle is to be avoided in mandibular injections and the external pterygoid in tuberosity injections. (Fig. 24.)

By inserting the needle in a mandibular injection either too far medially or too low, the internal pterygoid muscle will be entered.

In a tuberosity injection the external pterygoid muscle is invaded by directing the needle too far backward.

Note particularly in Fig. 25 these two muscles of mastication. Imagine that you are looking at them from behind with a view of the lingual surfaces of the teeth. On the right side the two muscles remain intact. You can see how the internal pterygoid muscle originates from the pterygoid fossa and how it extends downward and backward to be inserted into the lower portion of the ascending ramus. On the left side the internal pterygoid muscle has been removed so as to afford a clear view of the external pterygoid muscle. Observe how this muscle arises from the external surface of the external pterygoid plate (hence its name) and extends backward to be inserted into the neck of the condyle.

Also observe carefully on the right side of the pterygomandibular space, bounded externally by the ramus, internally by the internal pterygoid muscle and above by the external pterygoid muscle. This space in life is filled with adipose and areolar tissue. The anesthetizing solution should be injected into this space in making a mandibular injection.

Action of the Muscles of Mastication.

The opening of the mouth is effected by the weight of the mandible itself and the contraction of the muscles of the infrahyoid and suprahyoid regions. The masseter, temporal and internal pterygoid muscles, however, must relax to permit this. The closing of the mouth is effected by the contraction of those three muscles after their relaxation.

In protrusion of the mandible, the following muscles come into play: the superficial fibers of the masseter, the anterior fibers of the temporal and the external pterygoid. The deep fibers of the masseter and the posterior fibers of the temporal retract the mandible.

Lateral movement and trituration of the food is performed by the alternate action of the external pterygoid, assisted by the internal pterygoid muscle.

Thus it is evident that by injecting the anesthetic solution in any of these muscles there may be an interference with their normal functions. Edema may be established and the motor nerve filaments may be anesthetized, so that contraction and relaxation will be interfered with. Temporary fixation (false ankylosis) of the lower jaw is often the result of faulty injections. We shall dwell in detail on how to avoid these muscles in describing the technique of the various injections.

The Parotid Gland.

Of three principal salivary glands communicating with the oral cavity, the parotid is the one of greatest importance to the student in conduction anesthesia and its exact position and relation to surrounding structures should be carefully studied. The gland lies just below and in front of the ear, on the side of the face. It is located posteriorly to the ramus covering its posterior border and also the posterior border of the internal pterygoid and masseter muscles. It extends upward to the zygomatic arch and downward to the angle of the ramus. Two arm-like processes extend from the gland, one embraces the masseter muscle externally and the other projects on the internal surface of the internal pterygoid muscle. In the back the gland extends as far as the external auditory meatus and the mastoid process.

Duct of the Parotid Gland.

The duct of Stenson drains the salivary secretions of the parotid gland into the oral cavity. The duct perforates the buccinator muscle and opens upon the inner surface of the cheek by a small orifice in the mucous membrane of the buccinator muscle, opposite the upper second molar tooth.

Structures in the Parotid Gland.

In intimate relation with the parotid gland are a number of blood vessels and nerves, which play an important part with post injection complications in mandibular anesthesia. These structures are as follows: (Fig. 26.)

1. The external carotid artery and its two terminal branches, the internal maxillary and superficial temporal. The external carotid lies in a groove in the lower portion of the gland. It passes through the substance of the gland posteriorly to the neck of the condyle, where it divides into its two terminal branches.

2. The posterior facial vein lies within the substance of the gland slightly back of and internally to the posterior border of the ascending ramus. In a mandibular injection the vein is just in a line with the direction of the needle, should it be advanced back past the posterior border of the ramus.

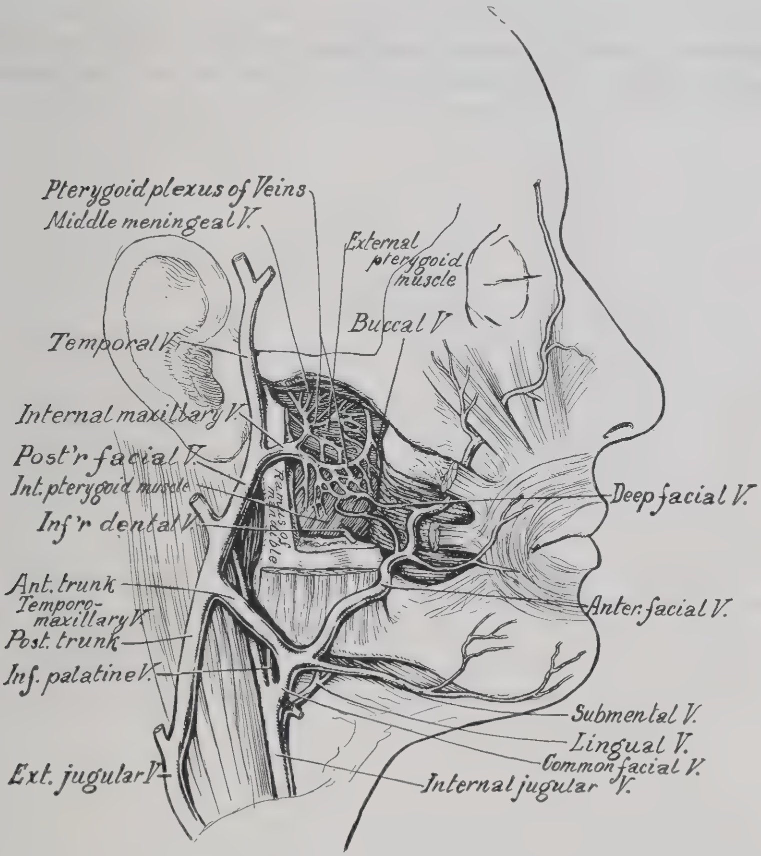

Pterygoid plexus of Veins
Middle meningeal V.
External pterygoid muscle
Buccal V
Temporal V.
Internal maxillary V.
Post'r facial V.
Int. pterygoid muscle
Inf'r dental V.
Ramus of mandible
Ant. trunk
Temporo-maxillary V.
Post. trunk
Inf. palatine V.
Ext. jugular V.
Deep facial V.
Anter. facial V.
Submental V.
Lingual V.
Common facial V.
Internal jugular V.

FIG. 27. Pterygoid plexus of veins, and its anastomosis with the anterior and posterior facial veins.

3. The facial nerve. The nerve leaves the cranium by the stylomastoid foramen and enters the posterior part of the gland at about its middle. It then extends forward and laterally, dividing into its distributing branches within the gland. These branches supply the various muscles of the face with motor impulses. The facial nerve lies externally to the external carotid artery and the posterior facial vein.

Very often, in mandibular injections, the needle may be inserted too far posteriorly and the parotid gland be invaded. Two things may then happen: the solution may either be deposited into the posterior facial vein and give rise to unpleasant toxic manifestations, or the facial nerve or some of its branches may be anesthetized. This latter may result in loss of motor control of some or all of the muscles of the face on the side where the injection was made. This condition is known as facial paralysis. There is, however, very little likelihood of entering the external carotid or the internal maxillary arteries, which are also imbedded in the parotid gland, on account of the tough, fibrous, slippery muscle coat that surrounds all arteries.

Veins Important in Conduction Anesthesia.

The dental surgeon is called upon to operate on a highly vascular area. It is a very difficult task, indeed, to keep away from blood vessels in the course of the various injections. Depositing the solution into the blood stream means increasing the toxicity of the injecting solution. Intravenous injections are productive of greater toxic manifestations than are intra-arterial, as the blood current in the former is toward the heart, while in the latter it is away from the heart. An artery is seldom, if ever, entered. The tunica media and externa of arteries are unusually strong, thick and elastic. A vein, however, may be entered with comparative ease because of the flabby, thin, venous walls. Injections of various anesthetics into the blood stream of animals have shown that intraärterial injections are about four times and intravenous injections about sixteen times as toxic in comparison with subcutaneous injections. It is, therefore, of great importance to us to know those veins which the anesthetist may encounter in the various injections and to know how to avoid them. The following are the veins to be considered:

The Pterygoid Plexus of Veins.

The pterygoid plexus of veins has been somewhat described together with the contents of the infratemporal fossa. This plexus lies within the infratemporal and the pterygopalatine fossæ. It drains the blood from the oral cavity, the teeth, gums and alveoli, orbit and pharynx. It communicates with the pharyngeal plexus on the medial surface of the internal pterygoid muscle and with the cavernous sinus through the foramen ovale above.

The plexus may be entered in tuberosity and posterior infraorbital injections. This may be accompanied, particularly in tuberosity injections, by an extensive exudation of venous blood, resulting in an immediate and large swelling. This condition is known as hematoma. The needle must be kept in close contact with the bony walls of the tuberosity and the zygomatic surface of the superior maxilla in these injections as much as possible in order to avoid the external pterygoid muscle and the venous plexus which surrounds this muscle.

The Internal Maxillary Vein.

The internal maxillary vein accompanies the first part of the internal maxillary artery and then communicates with the pterygoid plexus. This vein may be entered in a mandibular injection if the needle should be inserted too high, too far medially and posteriorly.

The Posterior Facial Vein.

The posterior facial vein has been mentioned in conjunction with the parotid gland. It is formed by the superficial and middle temporal veins just above the zygomatic arch. It then enters the parotid gland, slightly internally and posteriorly to the posterior border of the mandible. Here the internal maxillary vein joins the posterior facial, uniting in this manner the posterior facial vein with the pterygoid plexus of veins. The plexus communicates by an anastomosing branch with the anterior facial vein. The posterior facial vein leaves the parotid gland below, at the lower border of the angle of the ramus. Here it unites with the anterior facial vein to form the common facial vein. (Fig. 27.)

The Anterior Facial Vein.

The anterior facial vein commences as the angular vein at the medial commissure of the eyelid. It is formed by the junction of the supraorbital and frontal veins. The facial vein then passes downward to the anterior border of the masseter muscle and, by a branch, unites with the pterygoid plexus of veins. The anterior facial vein may be entered in an anterior infraorbital injection.

Thus it will be seen that there is a direct communication of the veins draining the anterior and posterior part of the head. The injection in one vein may carry the solution to a distant part and there be manifested by a blanching or discoloration. For example, the solution injected into the pterygoid plexus of veins in a tuberosity injection may be carried to the anterior facial vein and cause a blanching of tissues in the infraorbital region.

Besides these principal veins in the path of the hypodermic needle, there are numerous small veins, capillaries and arterioles, whose endothelial lining offers but little resistance toward the needle point. How to avoid the veins and how to determine whether a vein has been entered will be treated in the chapters dealing with the technique of the injections.

CHAPTER III.

TRIFACIAL NERVE AS APPLIED TO THE DENTAL SURGEON.

The fifth cranial nerve, or the trifacial nerve, may truly be termed the "dental nerve." Every time we give pain to the patient some peripheral sensory nerve ending of the trifacial nerve is stimulated. An afferent impulse is transmitted to a certain center of the brain, creating the uncomfortable sensation which we term pain. It is obvious that a thorough knowledge and understanding of the course and distribution of this nerve is imperative for the student of nerve blocking. Without this knowledge he will do his work blindly and in a haphazard manner, obtaining results occasionally but failing more frequently.

In describing the trifacial nerve, the writer will endeavor to eliminate all the non-essential parts and confine himself only to those branches which concern the dental surgeon and which have a direct or indirect bearing on nerve blocking injections.

The trifacial nerve, or the fifth cranial, is the only compound cranial nerve. By a compound nerve we mean one which has both sensory and motor roots.

The fifth cranial nerve arises by a number of fibers from the side of the pons Varolii. The two roots, the large sensory and the small motor, run together to the middle fossa. The sensory root forms a large ganglion in a depression on the anterior surface, at the apex of the petrous portion of the temporal bone. This is the Gasserian ganglion. The motor root does not enter into the formation of the Gasserian ganglion but passes beneath it. The sensory root transmits sensation to the head and face, while the motor root transmits motor impulses to the muscles of mastication.

From the Gasserian ganglion, three large branches are given off, each one serving certain definite areas. These branches are as follows:

1. The first division or ophthalmic. The sensory nerve of the eyeball, forehead and surrounding structures.
2. The second division or maxillary. This nerve transmits sensation to the upper jaw, gums, teeth, hard and soft palate, lower eyelid, upper lip and side of nose.

3. The third division or mandibular. The motor root of the trifacial nerve is incorporated with this division. The sensory root transmits sensation to the mandible, tongue, lower gums, teeth and lower lip. The motor root serves the muscles of mastication.

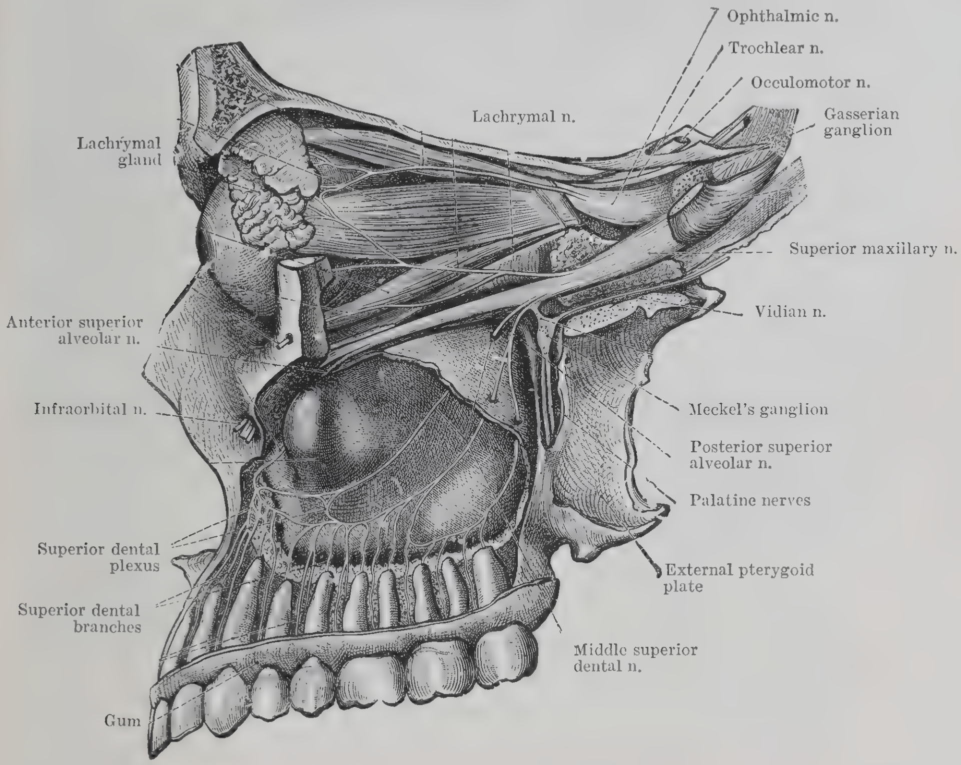

Ophthalmic n.
Trochlear n.
Occulomotor n.
Gasserian ganglion
Lachrymal n.
Lachrymal gland
Superior maxillary n.
Vidian n.
Anterior superior alveolar n.
Infraorbital n.
Meckel's ganglion
Posterior superior alveolar n.
Palatine nerves
Superior dental plexus
External pterygoid plate
Superior dental branches
Middle superior dental n.
Gum

FIG. 28. The ophthalmic and superior maxillary nerves and their distribution. (From Toldt's Anatomy.)

Ophthalmic Nerve.

The ophthalmic nerve concerns the ophthalmologist more than the dental surgeon and therefore we shall consider it but briefly and in a general way. It leaves the cranium and enters the orbit through the superior orbital (sphenoidal) fissure. Here it divides into three main branches. (Figs. 28 and 31.)

Lachrymal Nerve. The lachrymal nerve, which serves the lachrymal gland, the conjunctiva and the lateral commissure of the eye.

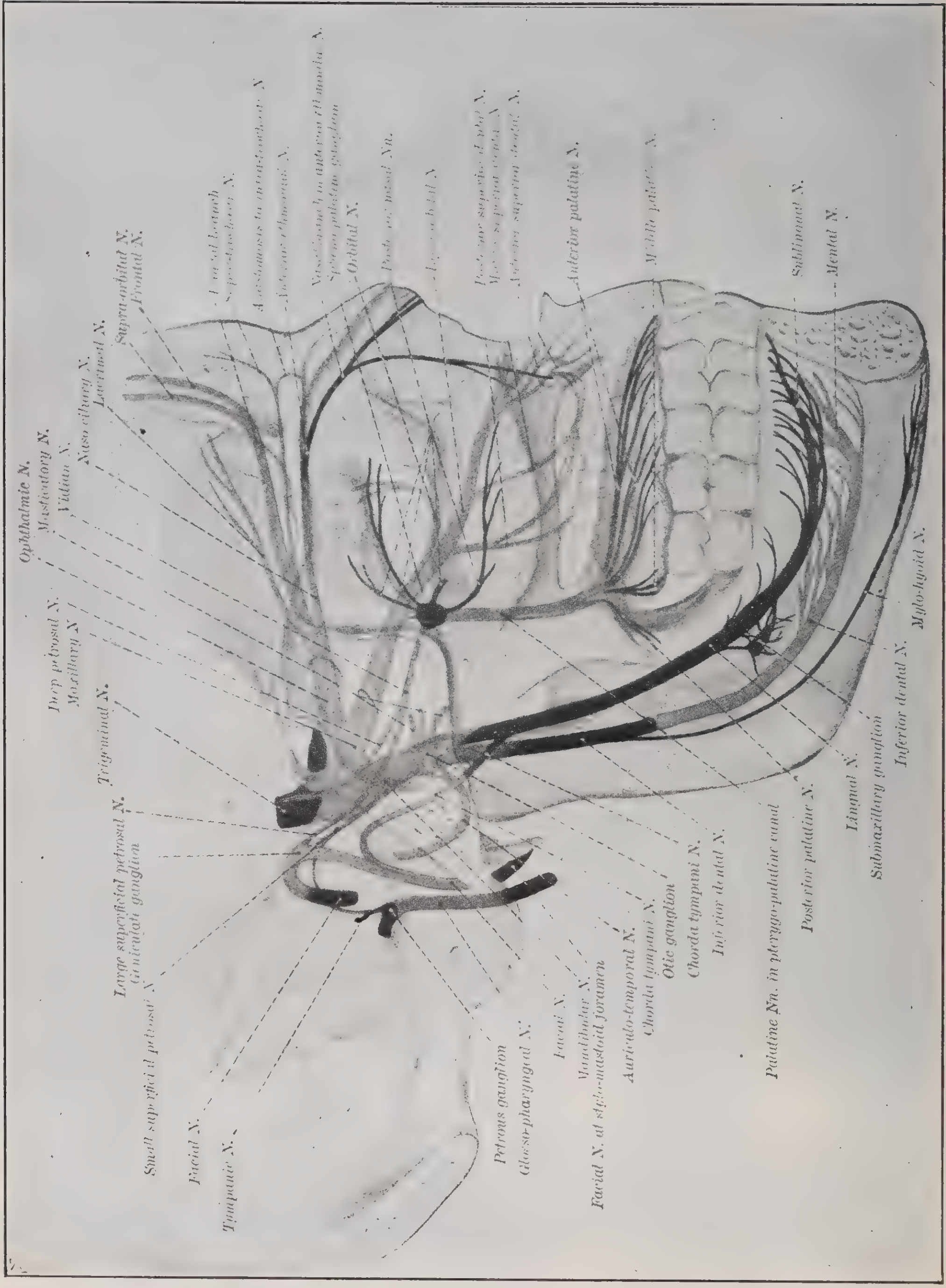

Ophthalmic N.
Masticatory N.
Vidian N.
Naso-ciliary N.
Lacrimal N.
Supra-orbital N.
Frontal N.
Nasal branch
Supratrochlear N.
Anastomosis to infratrochlear N.
Anterior ethmoidal N.
Spheno-palatine ganglion
Orbital N.
Posterior nasal Nn.
Infraorbital N.
Posterior superior dental N.
Middle superior dental N.
Anterior superior dental N.
Anterior palatine N.
Middle palatine N.
Sublingual N.
Mental N.
Deep petrosal N.
Maxillary N.
Trigeminal N.
Large superficial petrosal N.
Geniculate ganglion
Small superficial petrosal N.
Facial N.
Tympanic N.
Petrous ganglion
Glosso-pharyngeal N.
Facial N.
Mandibular N.
Facial N. at stylo-mastoid foramen
Auriculo-temporal N.
Chorda tympani N.
Otic ganglion
Chorda tympani N.
Inferior dental N.
Palatine Nn. in pterygo-palatine canal
Posterior palatine N.
Lingual N.
Submaxillary ganglion
Inferior dental N.
Mylo-hyoid N.

Fig. 29. Trifacial nerve. Light lines are the branches running in bony structures; dark lines, those running in soft tissues. (After Sobotta.)

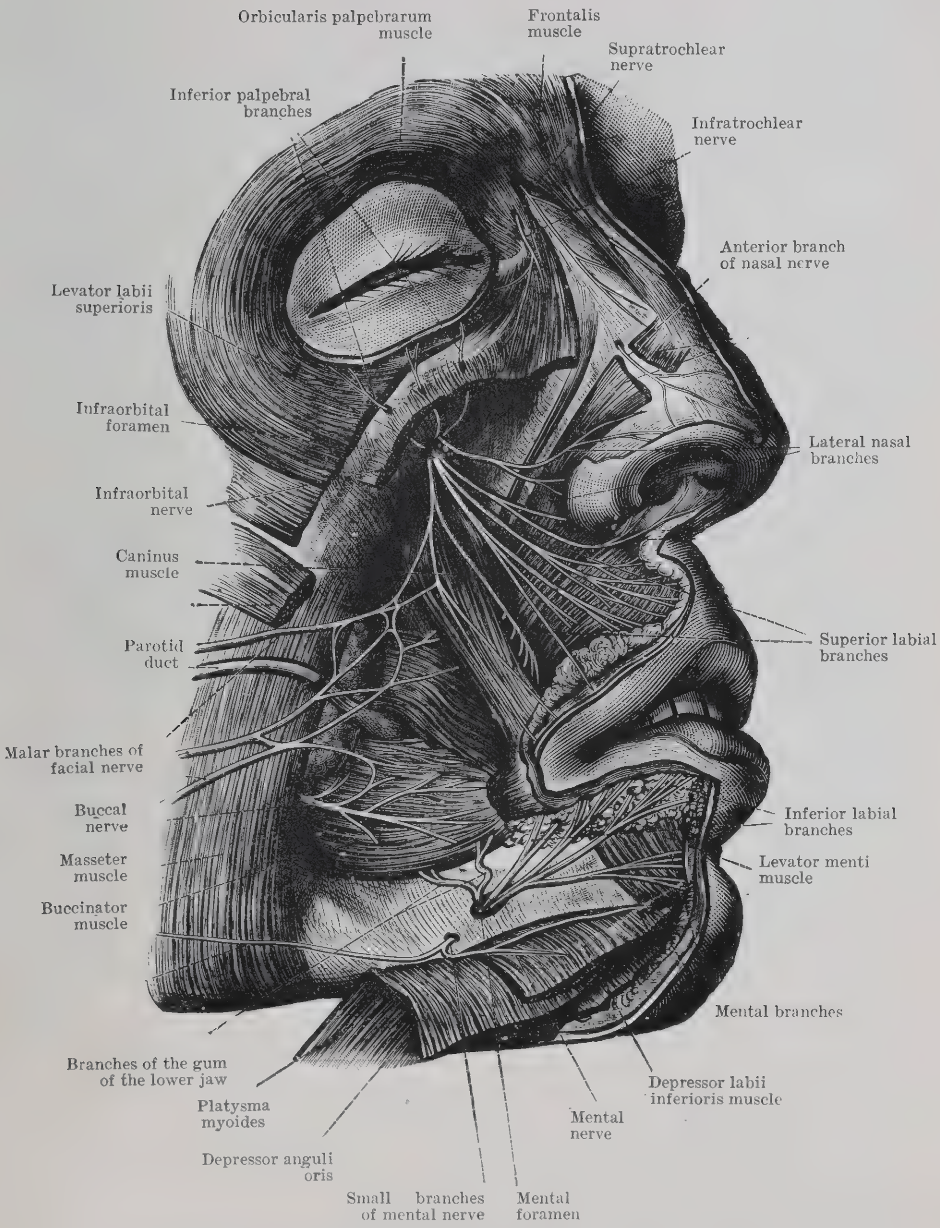

Orbicularis palpebrarum muscle
Frontalis muscle
Supratrochlear nerve
Inferior palpebral branches
Infratrochlear nerve
Anterior branch of nasal nerve
Levator labii superioris
Infraorbital foramen
Lateral nasal branches
Infraorbital nerve
Caninus muscle
Superior labial branches
Parotid duct
Malar branches of facial nerve
Buccal nerve
Inferior labial branches
Masseter muscle
Levator menti muscle
Buccinator muscle
Mental branches
Branches of the gum of the lower jaw
Platysma myoides
Depressor labii inferioris muscle
Mental nerve
Depressor anguli oris
Small branches of mental nerve
Mental foramen

FIG. 30. The terminal branches of the infraorbital nerve. The cutaneous nerves of the nose, upper and lower lip and lower eyelids. (From Toldt's Anatomy.)

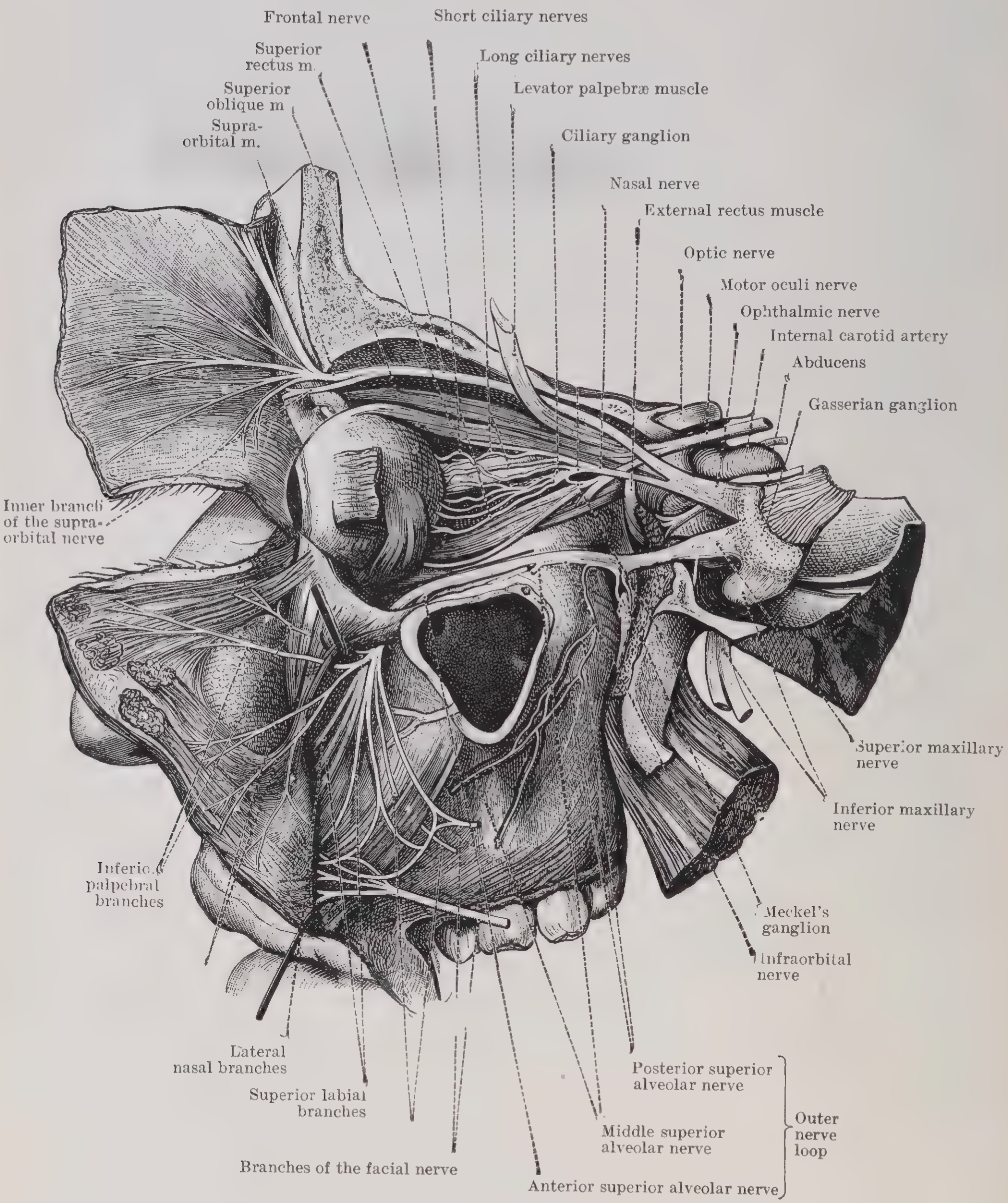

Frontal nerve
Short ciliary nerves
Superior rectus m.
Long ciliary nerves
Superior oblique m
Levator palpebræ muscle
Supra-orbital m.
Ciliary ganglion
Nasal nerve
External rectus muscle
Optic nerve
Motor oculi nerve
Ophthalmic nerve
Internal carotid artery
Abducens
Gasserian ganglion
Inner branch of the supra-orbital nerve
Superior maxillary nerve
Inferior maxillary nerve
Inferior palpebral branches
Meckel's ganglion
Infraorbital nerve
Lateral nasal branches
Posterior superior alveolar nerve
Superior labial branches
Outer nerve loop
Middle superior alveolar nerve
Branches of the facial nerve
Anterior superior alveolar nerve

FIG. 31. The superior maxillary nerve or second division of the fifth cranial. The outer nerve loop. (From Toldt's Anatomy.)

Frontal Nerve.

The frontal nerve, which by its supraorbital branch serves, after leaving the orbit by the supraorbital notch, the forehead, the scalp as far back as the vertex, the upper eyelid and the frontal sinus. By its supratrochlear branch, the frontal nerve serves the medial commissure of the eye, part of the forehead and the root of the nose.

Nasociliary Nerve.

Finally by its nasociliary branch, the frontal nerve serves the eyeball, some of the muscles controlling the eyeball, the anterior third of the nasal septum and the lateral wall of the nasal cavity. (See large trifacial nerve chart and also Figs. 28 and 31.)

The Second and Third Divisions of the Trifacial Nerve.

The second and third divisions of the trifacial nerve concern the dental surgeon and must be considered very carefully, particularly those branches which innervate the pulps, the dentinal tubuli, the alveoli, periosteum and the mucous membrane.

Course of Second and Third Divisions.

The second division runs in a horizontal direction, while the third division assumes a vertical position. This is quite in conformity with the structures each division serves. Namely, the second division innervates the upper teeth, while the third division drops down into the infratemporal region to enter the inferior dental canal, in order to innervate the lower teeth. The two divisions separate at the Gasserian ganglion, at almost right angles. (See trifacial nerve chart and also Figs. 29 and 31.)

Superior Maxillary Nerve.

The general course of the superior maxillary nerve is as follows: It leaves the cranium by the foramen rotundum, crosses the narrow pterygopalatine fossa, enters the infraorbital canal, runs through the infraorbital canal on the floor of the orbit and finally emerges on the face at the infraorbital foramen. Here it divides into three terminal branches:

(a) Nasal, serving the skin at the side of the nose.
(b) Labial, serving the upper lip.
(c) Inferior palpebral, serving the lower eyelid. (Figs. 30 and 31.)

Outer and Inner Nerve Loops.

When we think of the nerve supply of the upper teeth, we must remember that they are served by two distinct nerve loops—an outer nerve loop and an inner nerve loop. The outer nerve loop serves the pulps of the teeth, the fine nerve filaments actually passing through the apical foramina into the pulp chambers. It also serves the buccal alveolar plate of the molar and bicuspid teeth, the facial plate of the anterior teeth and the periosteum and mucous membrane covering the outer alveolar plate.

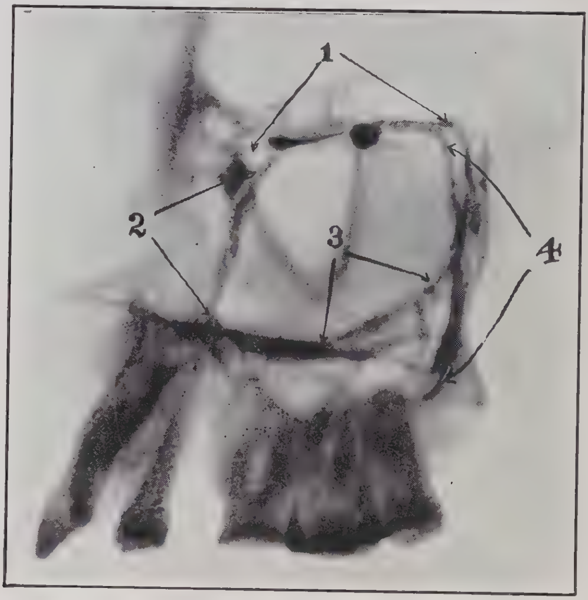


Fig. 32. Radiograph of superior maxillary bone. The infraorbital foramen and canal and the anterior, middle and posterior superior alveolar nerves are outlined with bismuth paste. 1. Infraorbital canal. 2. Anterior superior alveolar nerve. 3. Middle superior alveolar nerve. 4. Posterior superior alveolar nerve.

The inner nerve loop has no connection with the pulps of the teeth. This loop innervates only the lingual or palatal alveolar plates of the upper teeth and their soft coverings, the periosteum and mucous membrane. It is evident, therefore, that should it be necessary to extirpate pulps, grind teeth, prepare cavities or perform any other operation on the upper teeth which will not involve the lingual alveolar plate and the mucous membrane, the outer nerve loop only needs to be anesthetized. In extractions, removal of cysts or any surgical operations which, of necessity, infringe upon or involve the lingual or palatal plate, the inner nerve loop, as well as the outer, must be anesthetized to obtain complete anesthesia.

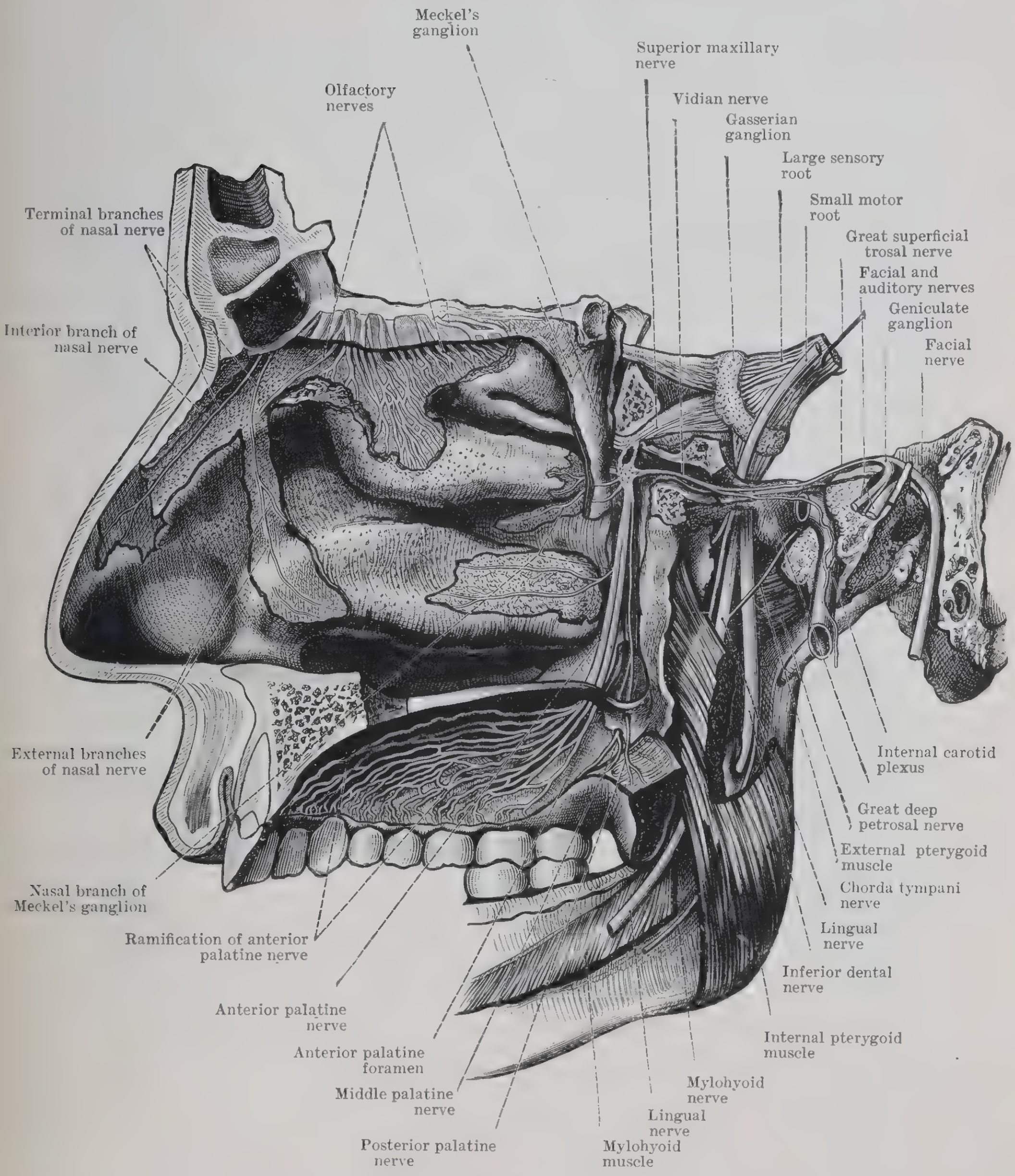

Meckel's ganglion
Superior maxillary nerve
Olfactory nerves
Vidian nerve
Gasserian ganglion
Large sensory root
Small motor root
Terminal branches of nasal nerve
Great superficial trosal nerve
Facial and auditory nerves
Geniculate ganglion
Interior branch of nasal nerve
Facial nerve
External branches of nasal nerve
Internal carotid plexus
Great deep petrosal nerve
External pterygoid muscle
Nasal branch of Meckel's ganglion
Chorda tympani nerve
Lingual nerve
Ramification of anterior palatine nerve
Inferior dental nerve
Anterior palatine nerve
Internal pterygoid muscle
Anterior palatine foramen
Mylohyoid nerve
Middle palatine nerve
Lingual nerve
Posterior palatine nerve
Mylohyoid muscle

FIG. 33. Inner nerve loop. Meckel's ganglion and its branches. (From Toldt's Anatomy.)

Outer Nerve Loop.

Posterior Superior Alveolar Nerve.

Let us consider the outer nerve loop. Before the second division enters the infraorbital canal and becomes the infraorbital nerve, a branch is given off, the posterior superior alveolar nerve, which runs downward along the zygomatic surface of the superior maxillary bone, enters the posterior superior alveolar canals (there may be one or several branches), runs in a special canal in the substance of the zygomatic surface and

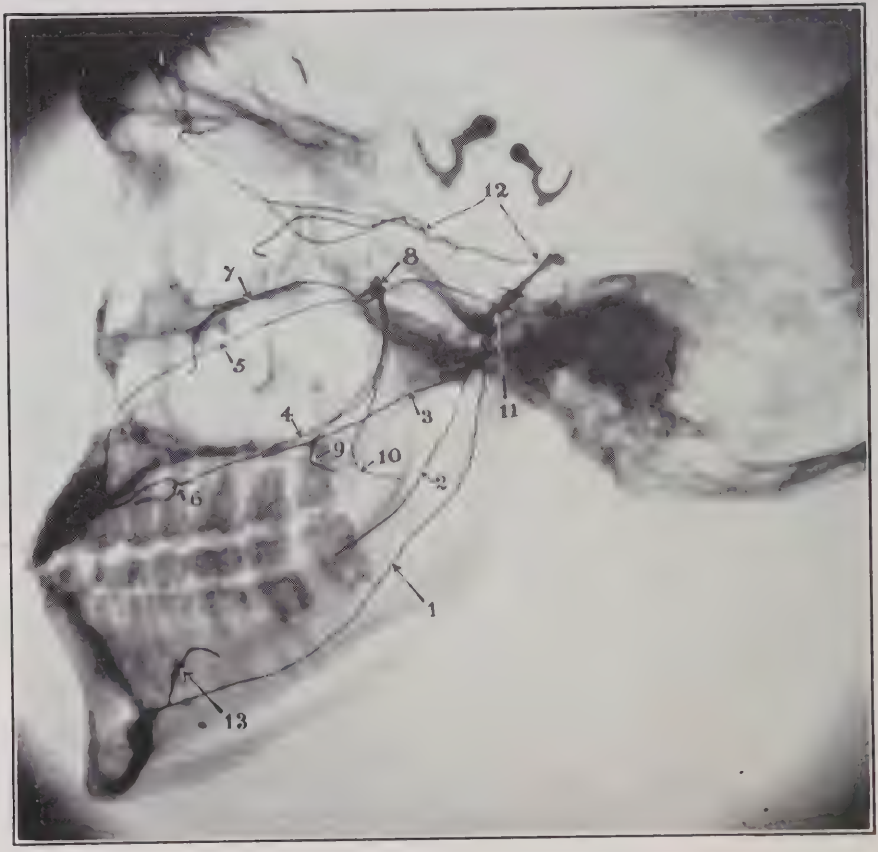


Fig. 34. Radiograph of dry skull with the copper wires drawn through the foramina and canals following the course of the various branches of the trifacial nerve. 1. Inferior dental nerve. 2. Lingual nerve. 3. Long buccal nerve. 4. Anterior palatine nerve. 5. Nasopalatine nerve. 6. Anastomosis of anterior palatine and nasopalatine nerves. 7. Infraorbital nerve. 8. Meckel's ganglion. 9. Middle palatine nerve. 10. Posterior palatine nerve. 11. Gasserian ganglion. 12. Ophthalmic nerve and its branches. 13. Mental foramen and nerve.

finally by a number of fine branches passes through the apical foramina of the roots of the three upper molar teeth forming the neural portion of the pulp tissue. Other branches are given off at the same time which serve the buccal alveolar plate of the upper molar teeth, the periosteum and a portion of the mucous membrane. Part of the buccal mucous membrane is innervated by the long buccal nerve. (See trifacial nerve chart and Figs. 28, 29, 31 and 32.)

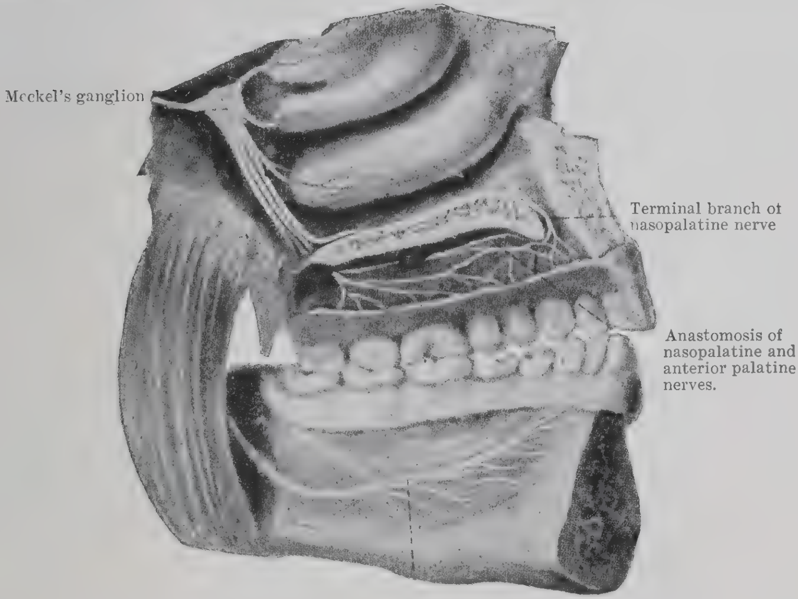

Meckel's ganglion
Terminal branch of nasopalatine nerve
Anastomosis of nasopalatine and anterior palatine nerves.

FIG. 35. Anastomosis of nasopalatine and anterior palatine nerves. Distribution of lingual nerves in the mandible. (After Buente and Moral.)

Middle Superior Alveolar Nerve.

Then, as the infraorbital nerve runs along the infraorbital canal, at some point in the canal, its location being inconstant, another branch is given off, the middle superior alveolar nerve. This branch also runs in a special canal in the facial surface of the superior maxillary bone, and ramifying enters through the apices of the two upper bicuspid teeth, serving their pulp tissue, buccal alveolar plate, periosteum and mucous membrane. (Figs. 28, 29, 31 and 32.)

Anterior Superior Alveolar Nerve.

Finally, just before the infraorbital nerve comes out on the face at the infraorbital foramen, about a quarter of an inch posteriorly to the infraorbital foramen, a third branch is given off, the anterior superior alveolar nerve. This branch also runs in a special canal in the facial surface of the maxilla and serves the central, lateral and cuspid teeth, their facial alveolar plate, periosteum and mucous membrane. (Figs. 28, 29, 31 and 32.)

Superior Dental Plexus.

The above description, however, must be somewhat modified. The three branches, before they enter the apical foramina of the teeth, form the superior dental plexus, from which fine filaments are given off and pass through the apical foramina. The middle superior alveolar anastomoses with the posterior superior alveolar, forming a small enlargement, the ganglion of Valentine. It also anastomoses with the anterior superior alveolar, and forms a similar enlargement, the ganglion of Bochdalek. This explains the frequent failure to obtain anesthesia in the first upper molar tooth with a tuberosity injection. Although the posterior superior alveolar nerve is anesthetized, yet the middle superior alveolar, by anastomosis, may carry sensation to the first molar tooth, particularly its anterobuccal root.

The Inner Nerve Loop and Meckel's Ganglion.

The inner nerve loop is derived from Meckel's ganglion which is located in the pterygopalatine fossa, just below the second division. Every ganglion generally has incorporated in it the three kinds of nerve cells. The sensory source of Meckel's ganglion are two short branches from the second division. The vidian nerve, which joins the ganglion at its posterior portion, is formed by the junction of the great superficial petrosal, a motor nerve and the deep petrosal nerve, a branch from the sympathetic plexus on the internal carotid artery. (Figs. 29, 33, 34 and 35.)

A number of branches are given off from Meckel's ganglion which are important from the standpoint of the anesthetist. These branches may be divided into four groups as to distribution:

(a) The ascending branches. These pass to the orbit.

(b) The posterior branches. These serve the upper part of the pharynx and the back part of the roof of the nose.

(c) The descending branches, which innervate the palate.

(d) The internal branches, serving the nose.

The last two groups, namely, the descending and internal, form the inner nerve loop and therefore we shall consider them more in detail.

The descending branches are three in number, the anterior, middle and posterior palatine. (See trifacial nerve chart.)

The Anterior Palatine Nerve.

The anterior palatine descends through the posterior palatine canal, and enters the oral cavity at the posterior palatine foramen. It then runs together with the artery in a special groove formed at the junction of the palate and alveolar processes, as far as the cuspid tooth. This nerve innervates the hard palate, its periosteum and mucous membrane and incidentally with it the palatal alveolar plate, periosteum and mucous membrane over the molar and bicuspid teeth. In the posterior palatine canal the inferior nasal branches are given off, which serve the inferior turbinated bone and the inferior and middle meatus of the nose. (Figs. 33, 34, 35 and 36.)

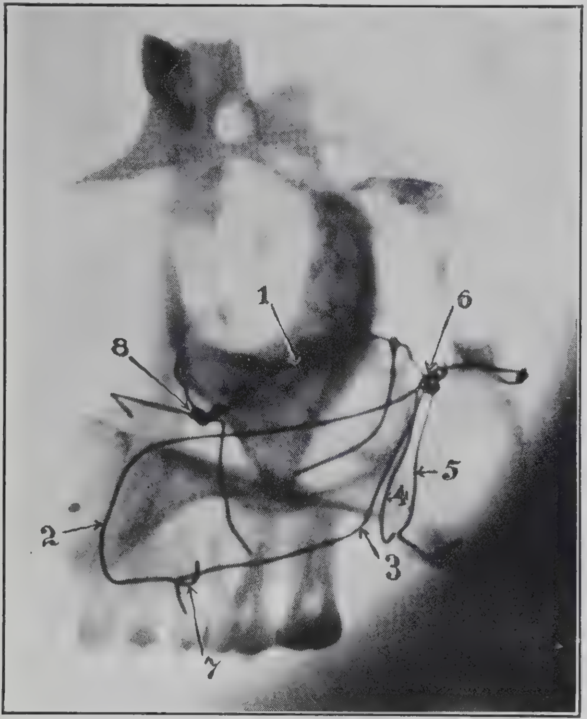


FIG. 36. Radiograph of superior maxillary bone articulated with nasal, part of sphenoid, malar, palate, and other bones entering into the formation of the orbit. Copper wires are passed through canals and foramina to reproduce the inner nerve loop, the infraorbital nerve and the posterior superior alveolar nerves. 1. Infraorbital nerve. 2. Nasopalatine nerve. 3. Anterior palatine nerve. 4. Middle palatine nerve. 5. Posterior palatine nerve. 6. Meckel's ganglion. 7. Anastomosis of nasopalatine and anterior palatine nerves.

Middle Palatine Nerve.

The middle palatine nerve emerges from an accessory palatine foramen and innervates the soft palate, uvula and upper portion of the palate.

Posterior Palatine Nerve.

The posterior palatine nerve also emerges from an accessory palatine foramen. It runs backward to serve the uvula, soft palate and tonsils. The middle and posterior palatine nerves, together with a branch of the glossopharyngeal and the vagus, form the tonsilar plexus for the innervation of the tonsils. (Figs. 33, 34 and 35.)

The internal branches consist of the superior anterior nasal and nasopalatine.

The superior anterior nasal, several in number, enter the nasal cavity through the sphenopalatine foramen and help to serve the posterior two-thirds of the nasal septum and the lateral nasal wall.

Nasopalatine Nerve.

The nasopalatine nerve enters the nasal cavity also through the sphenopalatine foramen, runs in a groove on the vomer bone, then through the two foramina of Scarpa, the left nerve running anteriorly to the right, finally entering the oral cavity by the anterior palatine (incisive) foramen. The two nasopalatine nerves serve the premaxillary bones and the lingual alveolar plate, periosteum and mucous membrane over the central, lateral and cuspid teeth on either side. The two nasopalatine nerves run as far as the cuspid teeth and here they anastomose with the anterior palatine nerves. (Figs. 33, 35 and 36.)

Thus, the inner nerve loop of the upper teeth is formed mainly by two branches from Meckel's ganglion, the anterior palatine and the nasopalatine. It is important to remember the anastomosis of these two nerves in the region of the cuspids, so that the lingual plate and mucous membrane of the cuspids are best anesthetized by infiltration anesthesia instead of an incisive injection, because sensation is also carried by the anterior palatine nerve.

The Mandibular Nerve.

The Sensory and Motor Roots.

The third division of the trifacial or the mandibular nerve leaves the cranium by the foramen ovale on the greater wing of the sphenoid and enters the infratemporal fossa just as soon as it leaves the cranium. The nerve immediately divides into two roots, an anterior motor and posterior sensory. The sensory root is the larger of the two and is derived directly from the Gasserian ganglion, while the small motor root runs beneath the Gasserian ganglion, joins the sensory root outside the foramen and immediately is again separated from it. (See trifacial nerve chart.)

The Motor Root.

The motor root serves four of the five muscles of mastication with motor impulses and the four branches are named according to the muscles to which they go, namely, masseter, temporal, external pterygoid and internal pterygoid.

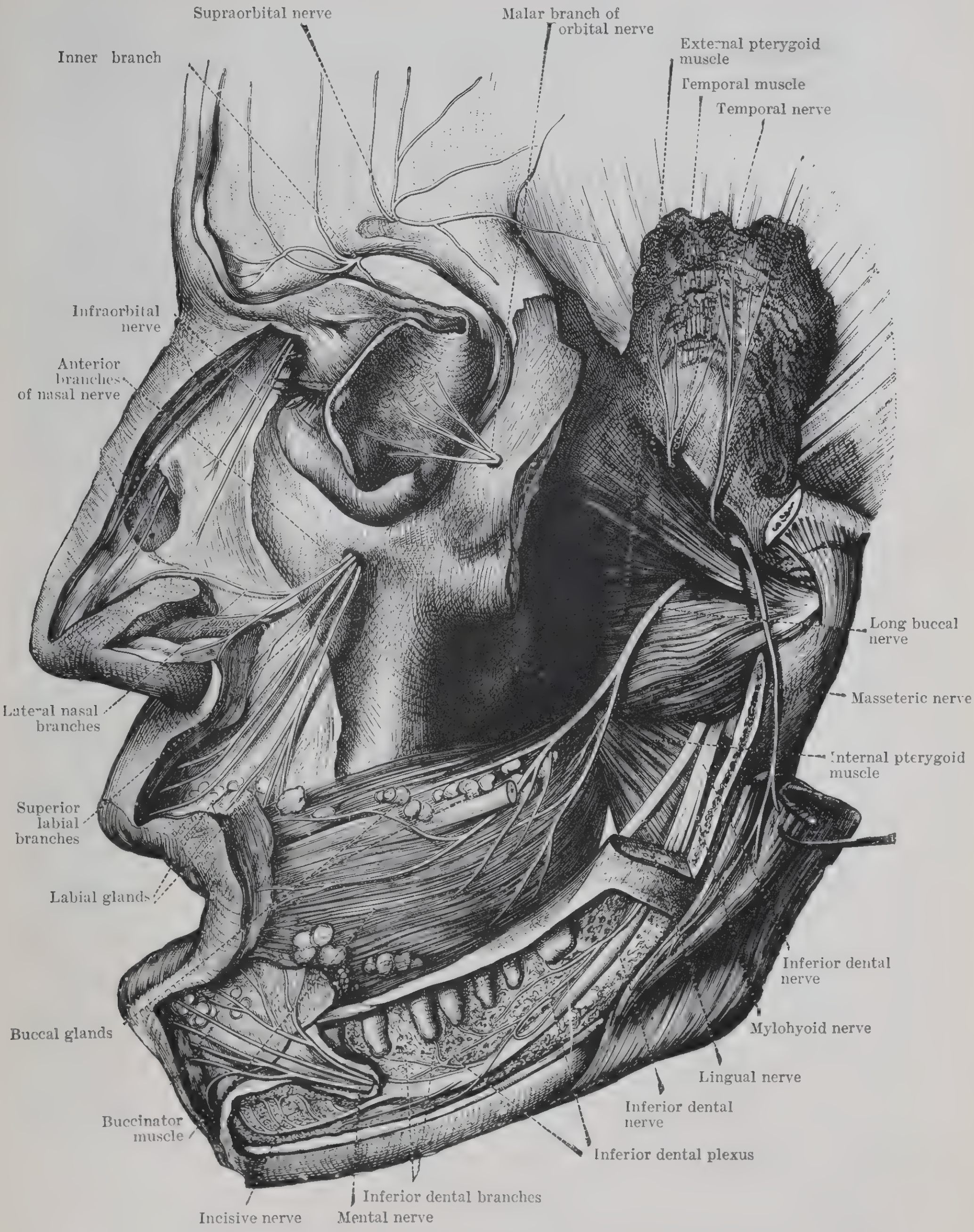

Supraorbital nerve
Malar branch of orbital nerve
Inner branch
External pterygoid muscle
Temporal muscle
Temporal nerve
Infraorbital nerve
Anterior branches of nasal nerve
Long buccal nerve
Masseteric nerve
Lateral nasal branches
Internal pterygoid muscle
Superior labial branches
Labial glands
Inferior dental nerve
Buccal glands
Mylohyoid nerve
Lingual nerve
Inferior dental nerve
Buccinator muscle
Inferior dental plexus
Inferior dental branches
Incisive nerve
Mental nerve

FIG. 37. Branches of the mandibular nerve, third division of the fifth cranial. (From Toldt's Anatomy.)

The Long Buccal Nerve.

The fifth muscle of mastication, the buccinator, is innervated by the largest branch of the anterior root of the mandibular nerve, the long buccal. This is a sensory nerve. The buccal branch of the facial (7th cranial) constitutes the motor nerve supply of the buccinator muscle. From the origin and insertion of the buccinator muscle we have learned that its lining mucous membrane forms the buccal mucous membrane of the upper and lower molar gums. In this manner this buccal mucous membrane has a distinct and separate nerve supply, namely, the long buccal nerve. (Figs. 19 and 37.)

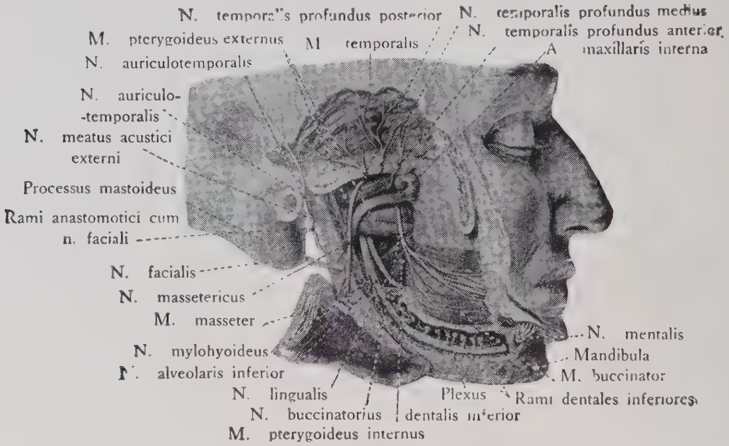

N. temporalis profundus posterior
N. temporalis profundus medius
M. pterygoideus externus
M. temporalis
N. temporalis profundus anterior
A. maxillaris interna
N. auriculotemporalis
N. auriculo-temporalis
N. meatus acustici externi
Processus mastoideus
Rami anastomotici cum n. faciali
N. facialis
N. massetericus
M. masseter
N. mylohyoideus
N. alveolaris inferior
N. lingualis
N. buccinatorius
M. pterygoideus internus
Plexus dentalis inferior
Rami dentales inferiores
N. mentalis
Mandibula
M. buccinator

FIG. 38. Branches and distribution of mandibular nerve. (After Spalteholz.)

Branches of Sensory Root.

The large sensory root of the mandibular nerve drops down beneath the external pterygoid muscle, gives off the auriculotemporal nerve by two roots, and then divides into two branches, the lingual and inferior dental. Let us consider each one separately.

Auriculotemporal Nerve.

The auriculotemporal nerve is given off by two roots which embrace the middle meningeal artery. The nerve passes backward into the parotid gland and then upward to the temple, innervating the temple and the scalp. (See trifacial nerve chart.)

The Lingual Nerve.

The lingual nerve runs downward anterior to the inferior dental nerve and beneath the external pterygoid muscle. It passes between the internal pterygoid muscle and the ascending ramus, then runs beneath the mucous membrane of the floor of the mouth close to the mandible near the apices of the lower wisdom tooth. Here it sweeps internally to the tongue, serving its anterior two-thirds with sensation and also innervating the lingual mucous membrane and periosteum of all the lower teeth. (Figs. 29, 35, 37, 38 and 39.)

Chorda Tympani.

The chorda tympani, a branch of the facial (7th cranial), joins the lingual nerve beneath the external pterygoid muscle accompanying it to the tongue. The chorda tympani is the secretory nerve to the submaxillary ganglion and forms the motor root of the ganglion, while the lingual nerve serves as the sensory root. (See trifacial nerve chart and Figs. 29 and 33.)

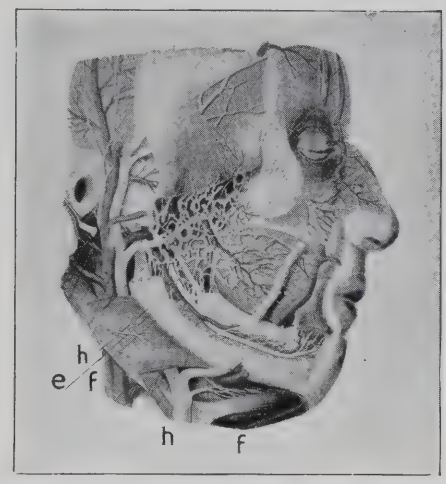


FIG. 39. E. Lingual nerve. F. Inferior dental nerve. H. Inferior dental artery. (After Sobotta.)

The dryness of the mouth after a mandibular injection is explained by the fact that the chorda tympani is anesthetized together with the lingual nerve, thus interfering with the secretions of the submaxillary gland.

It is interesting to note how pathological conditions in the mandible may give rise to pain in the ear and temple. The afferent impulse travels along the inferior dental or lingual nerve to the chorda tympani and the facial nerve. The facial nerve and the auditory are located in the internal auditory meatus and are united by a slender branch, the nervous intermedius. Thus the afferent impulse reaching the facial nerve is transmitted to the auditory, creating pain in the ear. Pain in the temple is carried by the inferior dental and the auriculotemporal nerves.

Inferior Dental Nerve.

This nerve, together with the inferior dental artery, passes from the inferior border of the external pterygoid muscle to the inferior dental foramen, lying on the outer surface of the sphenomandibular ligament. It traverses the mandibular canal in the body of the mandible, serving the alveoli of the molar teeth, and branches enter through the apices of the teeth, to innervate their pulps. At the mental foramen, the inferior dental nerve divides into the incisive, which is continued in the mandibular canal, serving the alveoli and the pulps of the bicuspids and anterior teeth and the mental nerve, which emerges from the mental foramen and serves the lower lip from the mental foramen to the median line, the buccal mucous membrane under the bicuspid teeth and the facial mucous membrane under the central, lateral and cuspid teeth. (Figs. 19, 29, 34, 37 and 38.)

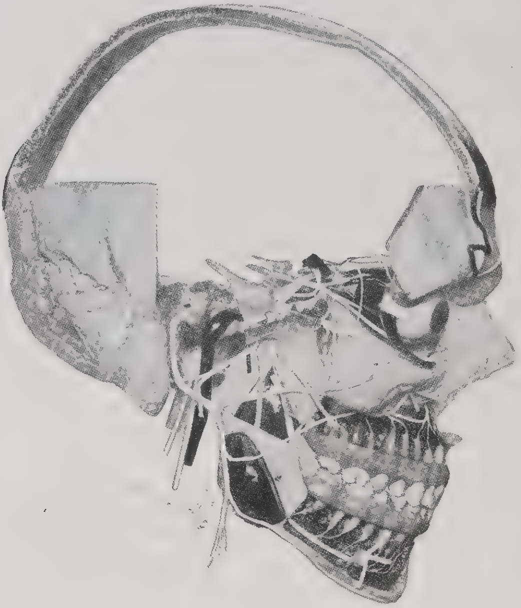


Fig. 40. Trifacial nerve reproduced on a dry skull, exposing the superior surface of the base of the skull and removing the outer lamina of the superior maxilla and mandible. (From the collection of the author.)

Fig. 41 represents a photograph from the collection of Dr. V. T. Kazanjian, of Boston, taken on the western war front. In this injury, part of the mandible was carried away, the superior maxillary and the nasal bones, with their surrounding structures, almost entirely destroyed, and yet, in spite of this destruction, the lingual and inferior dental nerves remain intact and may be clearly discerned. This impresses one with the fact that nerve tissues possess peculiar resistance to destruction. One need only take himself back to his college days in the dissecting room to recall how, in spite of indiscriminate slashing with the scalpel, the nerves generally miraculously survived.

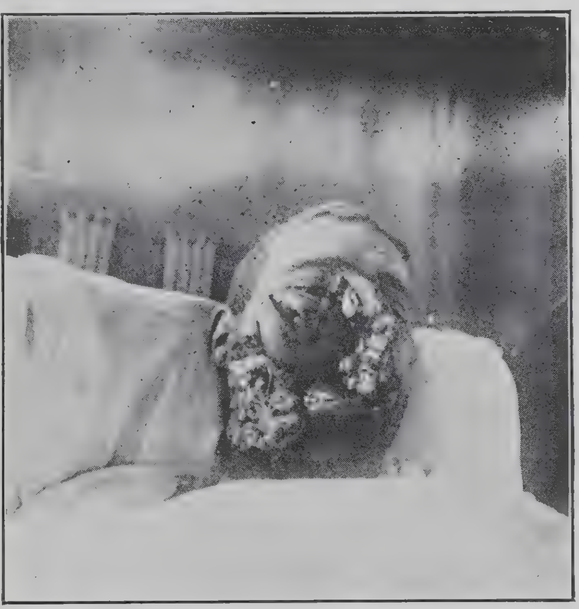


FIG. 41. Photograph from a collection of Dr. V. T. Kazanjian. Note the lingual and inferior dental nerves are intact in spite of great destruction of tissues.

Fig. 42 shows how Dr. Kazanjian, by plastic operations, restored the poor fellow to usefulness. Local anesthesia was used exclusively in the operations, as the ever present danger of bronchial pneumonia precluded the employment of inhalation narcosis.

The nerve supply of the lower teeth then is somewhat different than that of the upper. While the upper teeth are served by two distinct nerve loops, the lower teeth, their pulp and surrounding alveoli are served by the inferior dental nerve only.

The mucous membrane of the lower teeth, however, has three distinct sources of innervation. Lingually the mucous membrane is served by the lingual nerve. Buccally the mucous membrane of the lower molar teeth is served by the long buccal nerve. The buccal mucous membrane of the bicuspids and the facial mucous membrane of the anterior teeth is served by the mental nerve, which is a branch of the inferior dental.

In testing for anesthesia by compression, the mucous membrane only is accessible. It is essential, therefore, to know the innervation of the mucous membrane in order to understand which nerve or nerves have been blocked, when the mucous membrane in a certain area is tested to determine whether it has been anesthetized or not.

Determining Mandibular Anesthesia.

In testing for anesthesia after mandibular injection, the following points should be observed: Anesthesia in the lingual mucous membrane of the lower jaw would only indicate that the lingual nerve has been anesthetized.

Fig. 22.—Reconstruction of Fig. 21 by Dr. Kazanjian.

Anesthesia in the buccal mucous membrane of the lower molar region would only prove to us that the long buccal nerve has been anesthetized. The writer has seen many cases where there was anesthesia of the buccal mucous membrane of the molar region without anesthesia of the inferior dental nerve. It is only when the buccal mucous membrane in the bicuspid region is tested and found to be anesthetized that we know with certainty that the inferior dental nerve has been anesthetized, because this would indicate that the mental nerve is anesthetized, and since the mental nerve is a branch of the inferior dental and the solution has been deposited at the sulcus, it would follow that the inferior dental nerve has also been anesthetized.

The Facial Nerve.

The trifacial (5th cranial) is the sensory, while the facial (7th cranial) is the motor nerve of the face. The facial nerve emerges from the internal auditory meatus and canalis facialis by the stylomastoid foramen. It is embedded at first in the substance of the parotid gland. It then radiates into a number of branches, serving all the muscles of the face and also one of the muscles of mastication, the buccinator. (Figs. 43 and 44.)

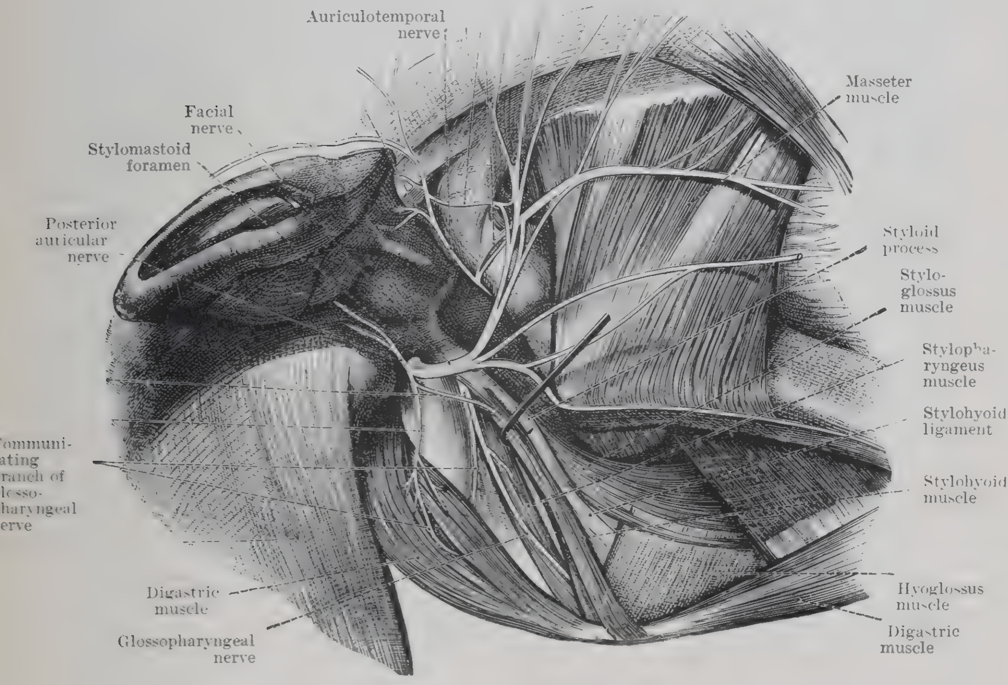

Auriculotemporal nerve
Facial nerve
Stylomastoid foramen
Posterior auricular nerve
ommuni- ating ranch of lesso- haryngeal erve
Digastric muscle
Glossopharyngeal nerve
Masseter muscle
Styloid process
Stylo- glossus muscle
Styloph a- ryngeus muscle
Stylohyoid ligament
Stylohyoid muscle
Hyoglossus muscle
Digastric muscle

Fig. 43. Emergence of facial nerve from stylomastoid foramen. (From Toldt's Anatomy.)

Two main divisions are given off in the parotid gland, the temporofacial and cervicofacial.

Temporofacial Branch.

The temporofacial passes upward and forward to serve the orbicularis palpebrarum, frontalis (muscle of the forehead), lower eyelid, muscles of the nose and upper lip. The infraorbital plexus is formed by the infraorbital branches of the facial and trifacial nerves.

Cervicofacial Branch.

The cervicofacial division passes downward and forward and serves the lower part of the face and the upper part of the neck, such as the lower lip, the chin, platysma and depressor anguli oris muscles, etc. The buccal branch serves the buccinator muscle.

The facial nerve because of its motor control of the muscles of the face is responsible for facial expression. All our emotions, such as anger, joy, fear, etc., are characterized by contraction or relaxation of the muscles of the face. This is accomplished by the efferent motor impulses from the brain through the facial nerve to the muscles of expression.

In a mandibular injection when the needle is passed too far back and into the parotid gland, the facial nerve may be anesthetized with a resultant drooping of the upper or lower lip, or lower eyelid. This is due to anesthetization of either the temporofacial or cervicofacial branches of the facial nerve or sometimes of the entire facial nerve.

CHAPTER IV.

BLOCKING THE SUPERIOR MAXILLARY NERVE AND ITS BRANCHES.

Nature benevolently cooperates with the dentist in nerve blocking. She forms foramina into which the operator's needle may find its way. She forms depressions and ridges serving as definite landmarks for the final position of the needle. The operator must study carefully and utilize all these various points of vantage to enable him to do the work better and with the least discomfort to the patient.

At the same time, in almost every injection, nature places a muscle, into and beyond which the anesthetist's needle should not venture. It is as though a sentinel had been placed with the warning, "thou shalt not pass, save at thine own risk."

Muscles Must Be Avoided.

In a previous chapter we have dealt with the importance of avoiding muscle tissues in nerve blocking injections.

First: because of their sensibility. Although the muscle fibers themselves are almost entirely devoid of sensation, yet between the muscle bundles are numerous small nerve filaments which are very sensitive to stimulation.

Second: because of the possibility of anesthetization of the motor nerve ending in the muscle tissues. Their motor control is interfered with and as a result there is a loss of the normal functions, namely contraction and relaxation.

Third: because absorption of the anesthetic solution in muscle tissue is very slow. It takes hours, and sometimes even days, before complete absorption takes place. Thus edema is established.

Anesthetization of the Three Upper Molar Teeth.

From the study of the trifacial nerve we have learned that the three upper molar teeth, their alveoli and gum tissues are served by two nerves, namely, the posterior superior alveolar from the outer nerve loop, and the anterior palatine nerve from the inner nerve loop. Therefore should we desire to grind an upper molar tooth, prepare a cavity, extirpate the pulp, or in fact do any dental work which would not infringe upon

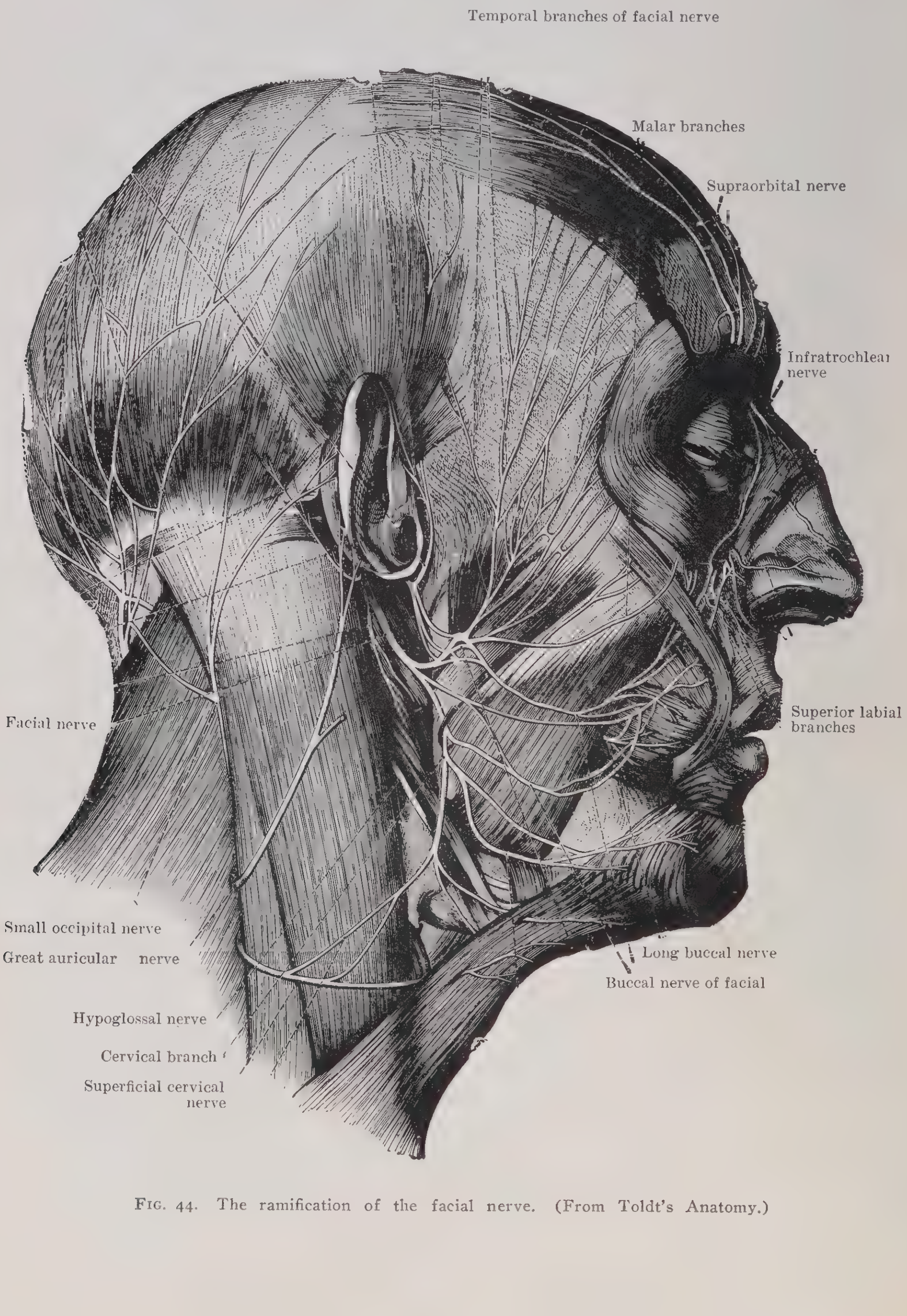

Temporal branches of facial nerve
Malar branches
Supraorbital nerve
Infratrochlear nerve
Superior labial branches
Facial nerve
Small occipital nerve
Great auricular nerve
Hypoglossal nerve
Cervical branch
Superficial cervical nerve
Long buccal nerve
Buccal nerve of facial

FIG. 44. The ramification of the facial nerve. (From Toldt's Anatomy.)

the palatal alveolar plate and mucous membrane, the posterior superior alveolar nerve needs only to be anesthetized.

In extraction, alveolectomy, or any other operation which would of necessity involve the palatal alveolar plate or gum tissue of the upper molar teeth, the anterior palatine nerve must be anesthetized also. Therefore we shall here consider the anesthetization of these two nerves.

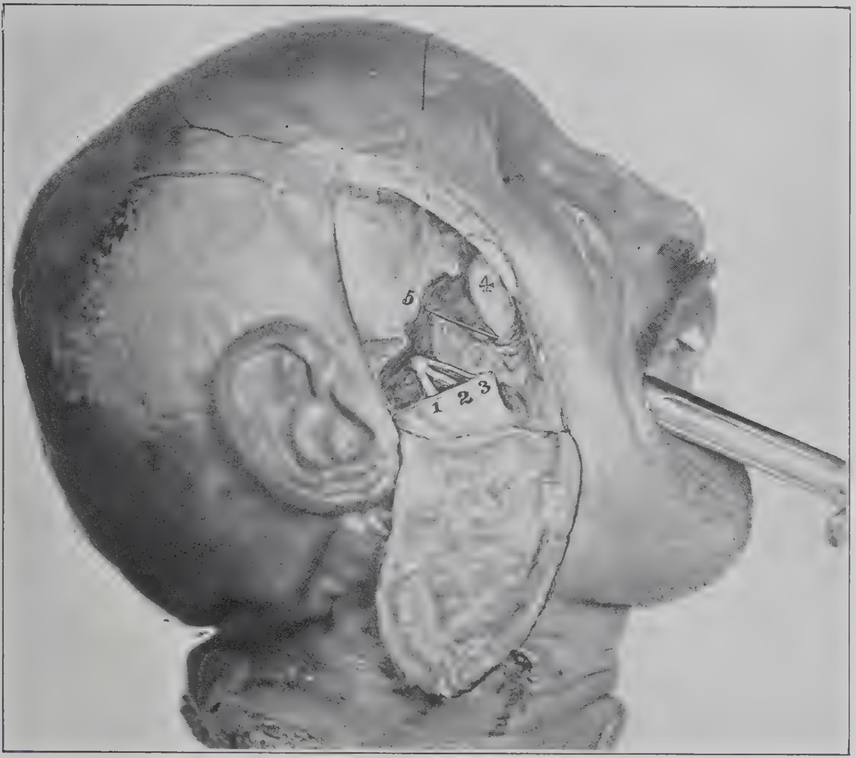


Fig. 45. Incorrect tuberosity injection. Needle is inserted too far back posteriorly and would enter the external pterygoid muscle, which has been removed from this specimen. Note that the needle is away from the tuberosity. 1. Inferior dental nerve. 2. Lingual nerve. 3. Long buccal nerve. 4. Tuberosity. 5. Under surface of greater wing of sphenoid. (From a preparation by the author.)

Tuberosity or Zygomatic Injection.

By means of this injection we anesthetize the posterior superior alveolar nerve as it enters the posterior superior alveolar foramen located on the zygomatic surface of the superior maxilla. We must remember that this surface is convex and that in order to reach the foramen, the point of the needle must be directed internally and superiorly, and the syringe held as far externally as the corner of the patient's mouth will permit. The external pterygoid muscle and the pterygoid plexus of veins must be carefully avoided in this injection; this is best accomplished by keeping the point of the needle in contact with bone.

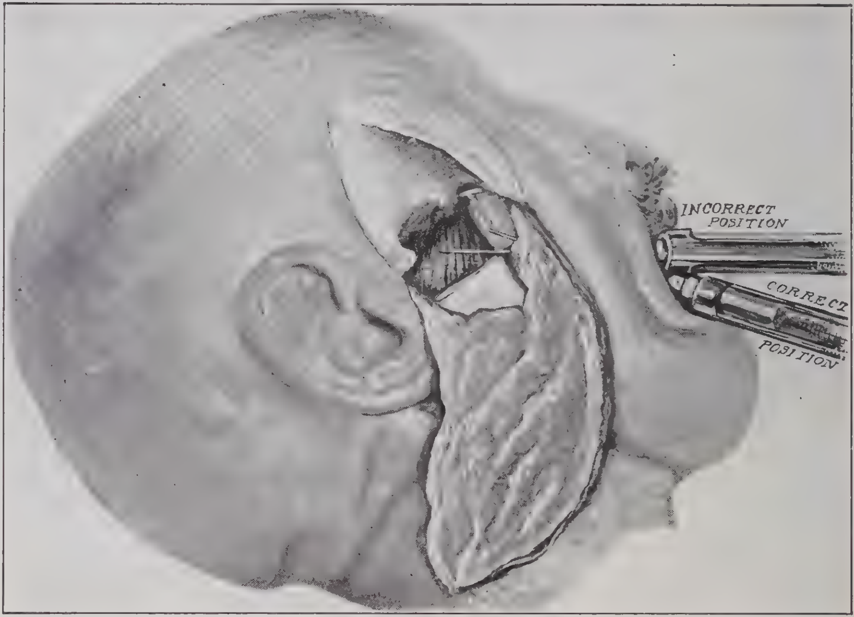


FIG. 46. Correct and incorrect position of syringe in a tuberosity injection. The syringe must swing externally as far as the corner of the mouth will permit in order to be in contact with the tuberosity. When it is directed parallel with the alveolar plate, needle will miss the tuberosity and enter the external pterygoid muscle and the pterygoid plexus of veins. (From a preparation by the author.)

The anesthetist must always visualize the position of the external pterygoid muscle as it arises from the external pterygoid plate and how it is directed toward the neck of the condyle. (Fig. 24.) If the needle should be projected too far posteriorly it would enter into the external pterygoid muscle. (Fig. 45.) Should the needle be directed parallel with the alveolar plate, without swinging the syringe externally, it would enter the pterygoid plexus of veins and also the external pterygoid muscle. (Fig. 46.) In either case edema may be established, and what is still worse, a condition known as hematoma (a cavity filled with blood) may result. This last condition is accompanied by an immediate and unusually large swelling. This apparently is formed by exudation of venous blood from the highly vascular pterygoid plexus, which has been entered by the

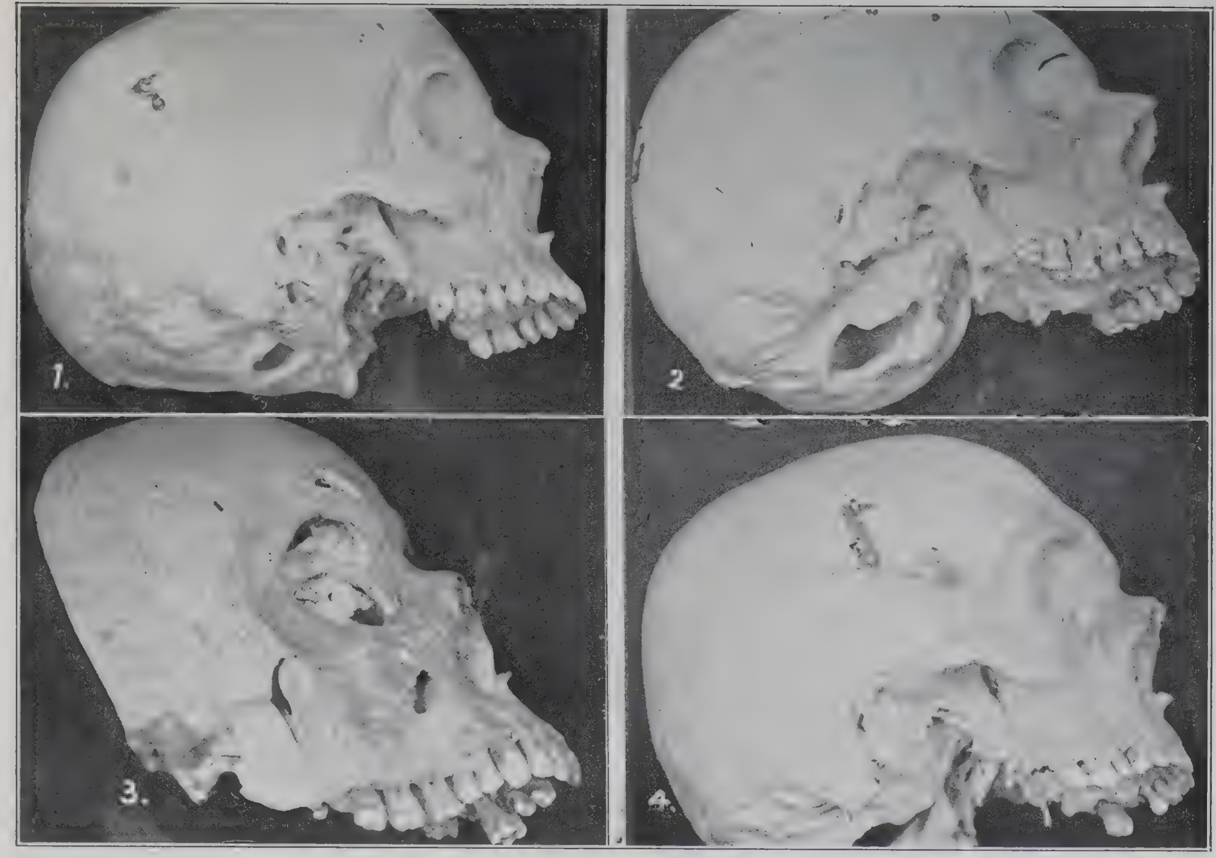


Fig. 47. Position of tuberosities in patients of various ages. Note also posterior superior alveolar foramina and cribriform appearance of the tuberosities. 1. Third molar has not as yet erupted. 2. Third molar erupting. 3. Third molar in position. 4. Third molar extracted on right side; first and third molars extracted on left side.

needle. The swelling, although alarming, generally disappears in a few days. Frequently the skin becomes discolored on account of blood stasis.

This unpleasant sequela could be almost entirely obviated, or at least reduced to a negligible minimum, by carefully avoiding the external pterygoid muscle and the venous plexus. This may be accomplished in the following manner:

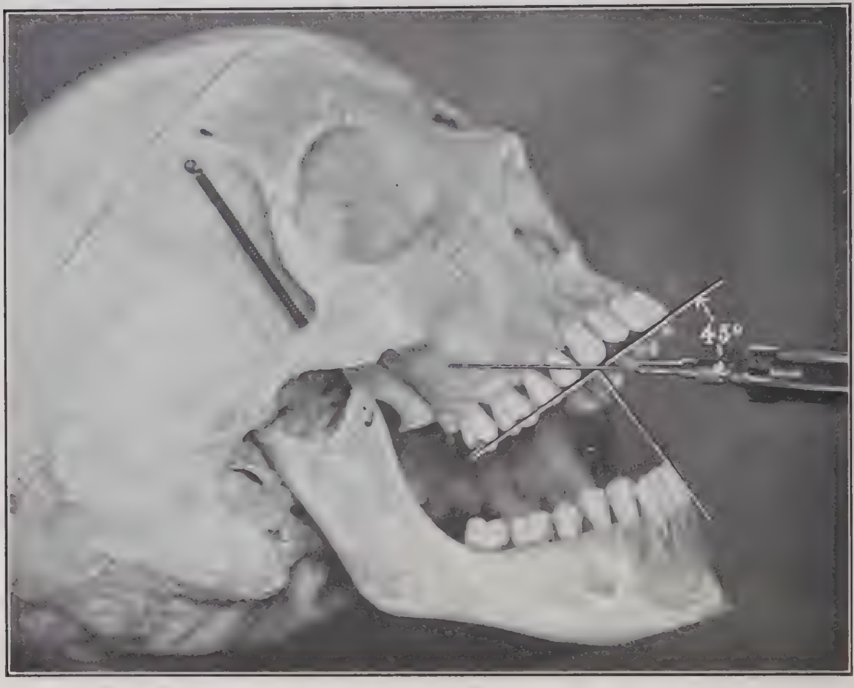


Fig. 48. Insertion of needle in a tuberosity injection. Note angle formed by syringe and occlusal plane of upper teeth.

Landmarks. The last two upper teeth are taken as a guide, irrespective of whether they have been extracted or not. The age of the patient also is taken into consideration. For instance, in an adult, after the eruption of the wisdom tooth, the second and third molars are taken as a guide. When the wisdom teeth have not erupted, the first and second molars are taken into consideration. In a child, of say ten years of age, the second premolar and sixth year molar are considered. The point is, that we wish to reach the posterior superior alveolar foramen on the tuberosity, which develops as the teeth erupt. In a child of ten the tuberosity is just back of the six year molar. At the age of fifteen the tuberosity will be back of the twelfth year molar. When manhood is attained, the tuberosity will be back of the wisdom tooth, while the sixth year molar will correspond approximately to the malar process. (Fig. 47.)

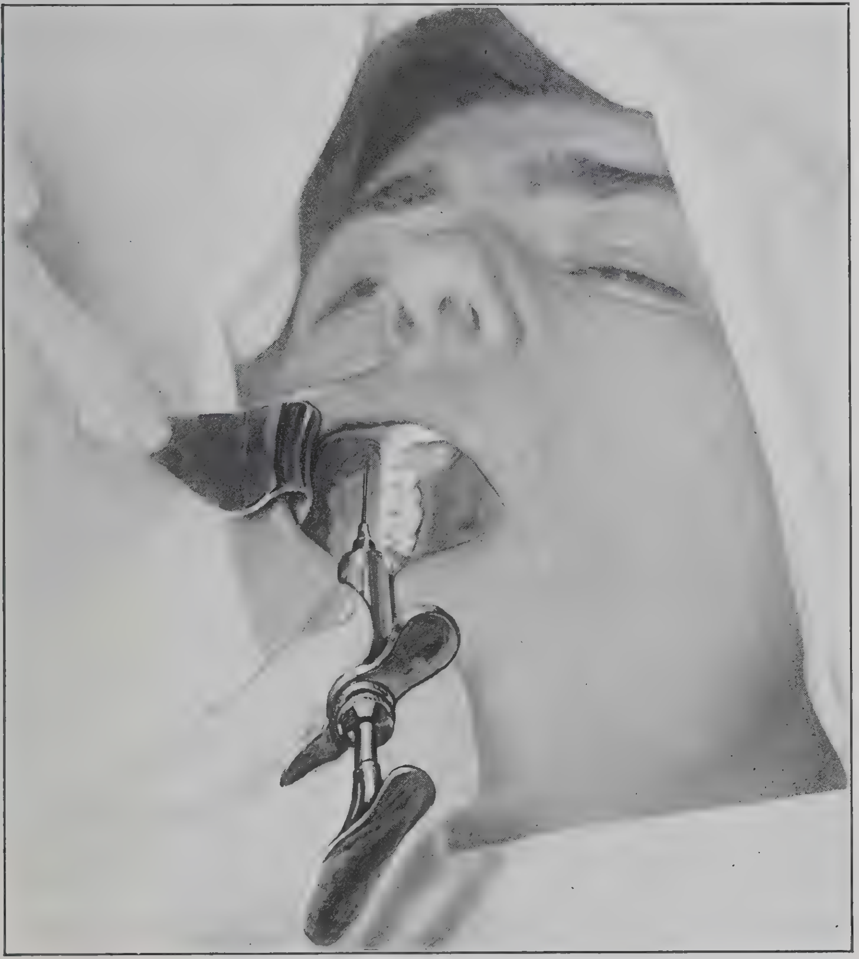


FIG. 49. Insertion of needle in a tuberosity injection on patient.

In case the teeth have been extracted we simply visualize the place which those teeth had occupied when they were in position.

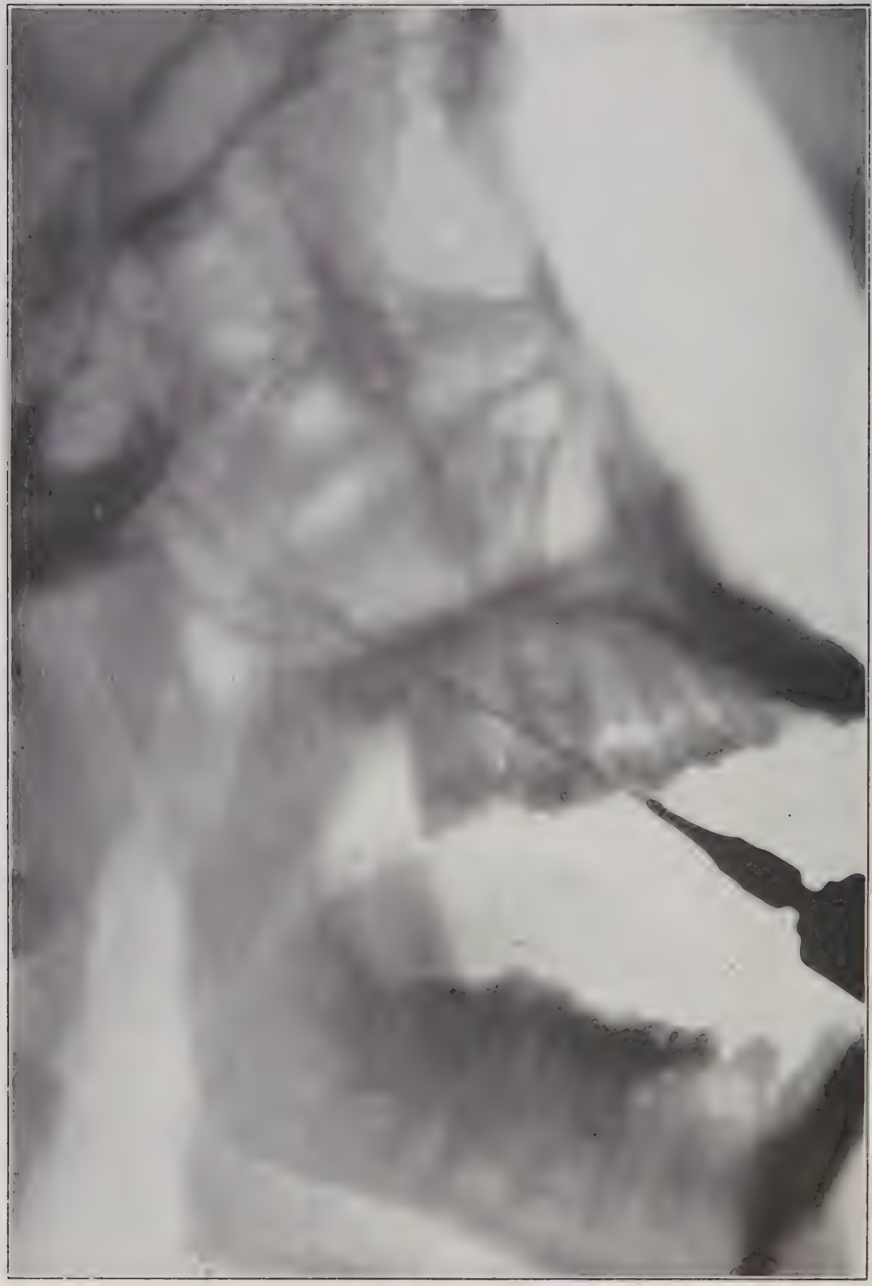


Fig 50. Radiograph showing insertion of needle in a tuberosity injection

Needle Employed. For this injection the author uses a 42 mm. 21 gauge needle, attached to the hub, of either iridio-platinum or steel. The reason for the heavy gauge needle is to enable the operator to keep it as much as possible in contact with the tuberosity of the superior maxillary bone.

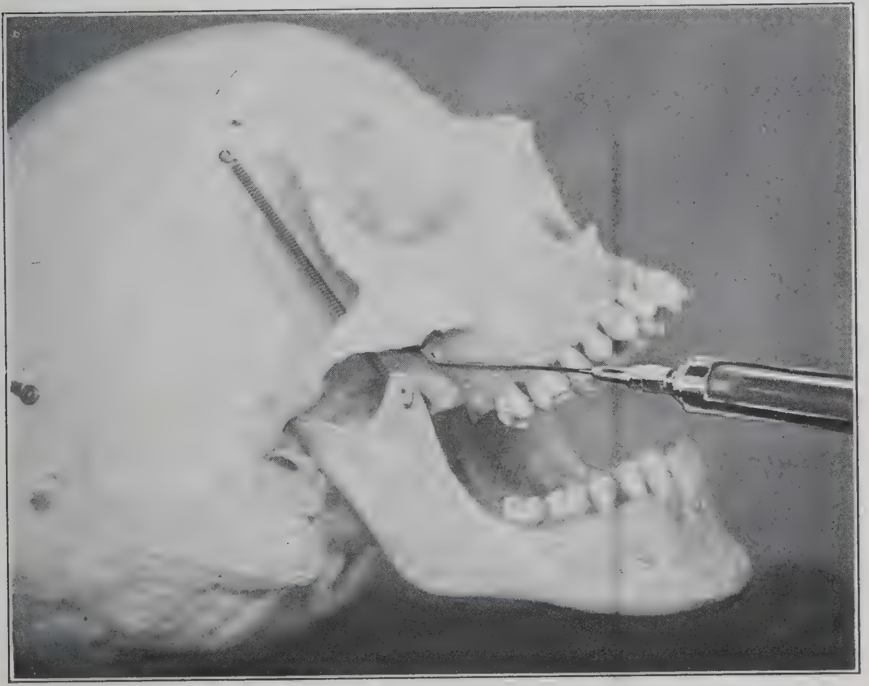


FIG. 51. Final position of needle in a tuberosity injection on dry skull.

Technique for Tuberosity Injection. Let us suppose that we are making this injection in an adult who has had the wisdom tooth erupted.

Standing in front of the patient, the lip is raised with the thumb and the index finger until the mucous fold is exposed.

The mucosa at the point of insertion is painted with 7 per cent iodin. The anesthetizing solution having been previously properly prepared, the needle sterilized, etc., we pick up the syringe in a pencil-like manner and insert the needle as high as possible, into the reflection of the mucous membrane, at the postero-buccal root of the second molar tooth, holding the syringe vertically parallel with the alveolar plate and at an angle of about 45 degrees with the occlusal surfaces of the upper molar and bicuspid teeth. (Figs. 48, 49, 50.) After passing through the buccinator muscle, the needle is directed over the root apices of the third molar, care being taken not to engage the periosteum. A few drops of the anesthetic solution are here injected. At this point, in order to reach the tuberosity and the posterior superior alveolar foramen, the syringe is held outwardly as far as the corner of the mouth will permit, and the needle progressed superiorly and internally, endeavoring in this manner, as much as possible, to remain in contact with the tuberosity. The needle is slowly and cautiously advanced, injecting a few drops as it progresses in order to establish a painless path, until about one inch (25 mm.) of the needle disappears, when the major part of the anesthetic solution is slowly injected. (Figs. 51, 52, 53, 54, 55 and 56.)

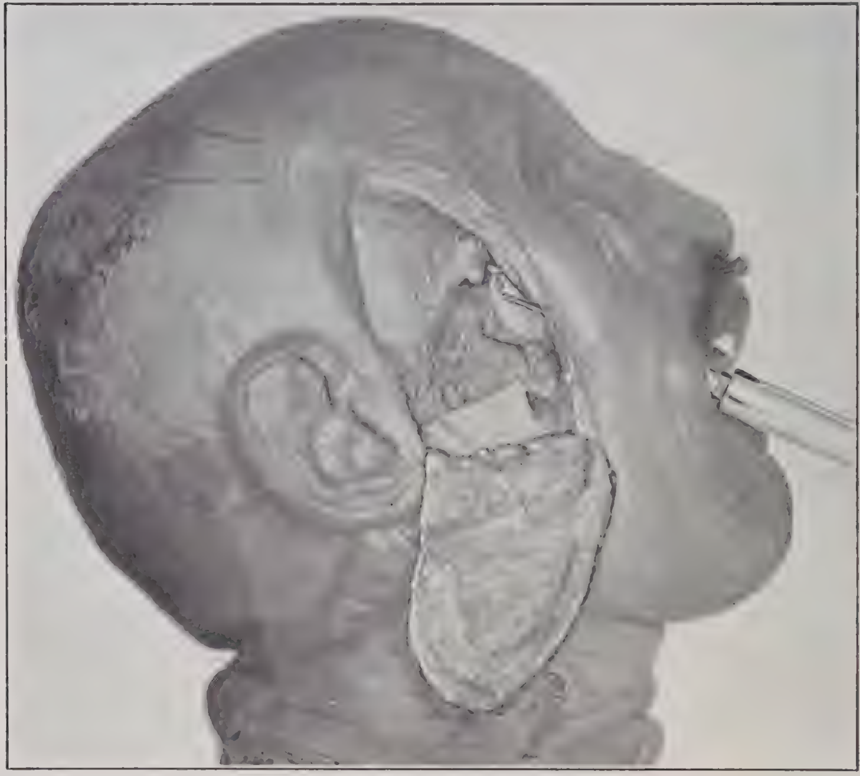


Fig. 52. Final position of needle in a tuberosity injection on wet specimen. (From a preparation by the author.)

Quantity Injected. The writer generally begins with a 2 c.c. syringeful of a 2 per cent procaine solution. Having injected all but 8 or 10 mm. at the tuberosity, he proceeds with the posterior palatine injection with the remaining solution, in order to complete the anesthesia of the three upper molar teeth without the necessity of refilling the syringe.

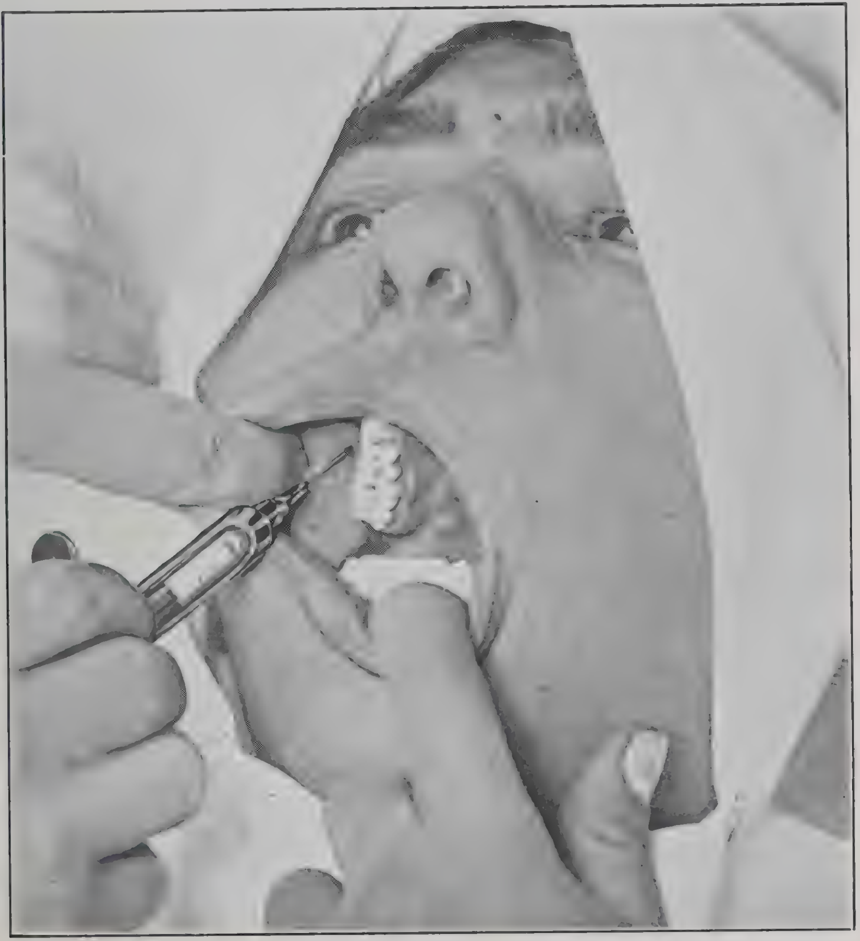


Fig. 53. Final position of needle in a tuberosity injection.

It is important to have the needle in close proximity to bone and the total length of the needle inserted into the tissues should not exceed 1 inch (25 mm.). Some text books advocate the insertion of the entire length of a 1⅝ inch (42 mm.) needle. This is entirely erroneous. The needle in such cases will be imbedded in the external pterygoid muscle and often will even strike the under surface of the greater wing of the sphenoid or the external pterygoid plate. (Fig. 45.) There is also a possibility of encountering the internal maxillary artery and invading the numerous interlacing veins around the external pterygoid muscles, resulting in hematoma. The solution will be injected so far away from the posterior superior alveolar nerve that anesthesia may be very superficial or entirely absent, although in a good many cases the anesthetic solution may, by

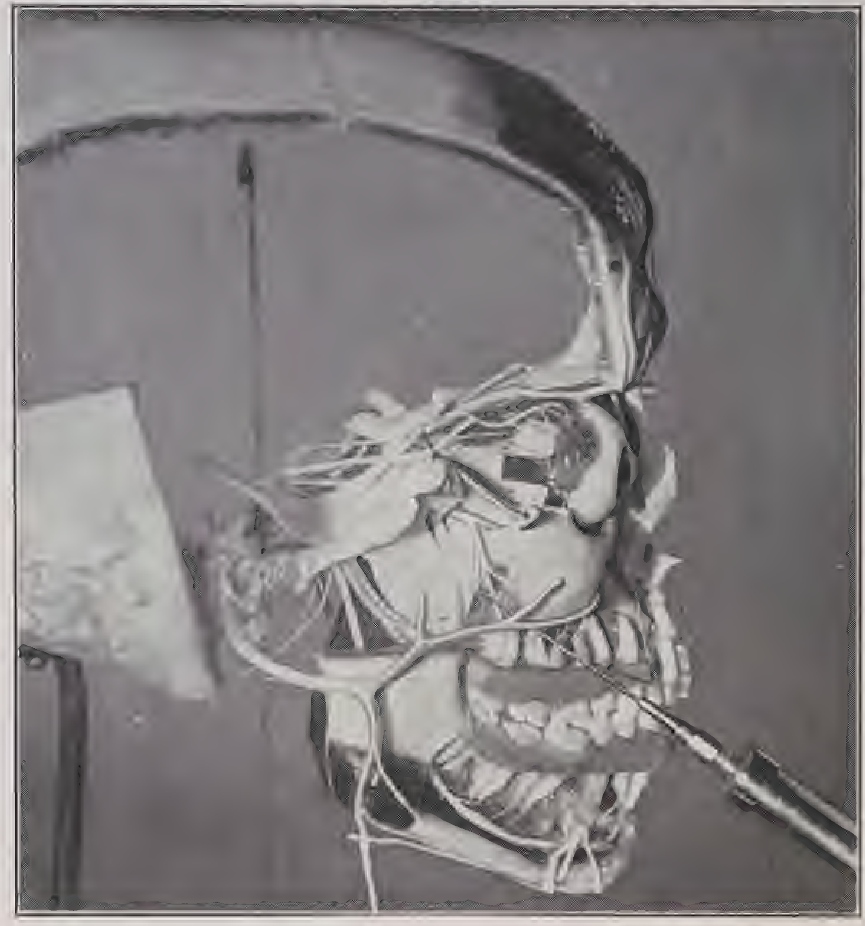


Fig. 54. Final position of needle in a tuberosity injection on an artificially prepared specimen. (From the collection of the author.)

diffusion (and good luck) finally reach and anesthetize the posterior superior alveolar nerve. At the same time it must be remembered that the improper direction of the needle, namely away from the zygomatic surface, and in a straight line with the alveolar plate, will carry the needle into the vascular pterygoid plexus, frequently causing venous exudation. (Fig. 27.)

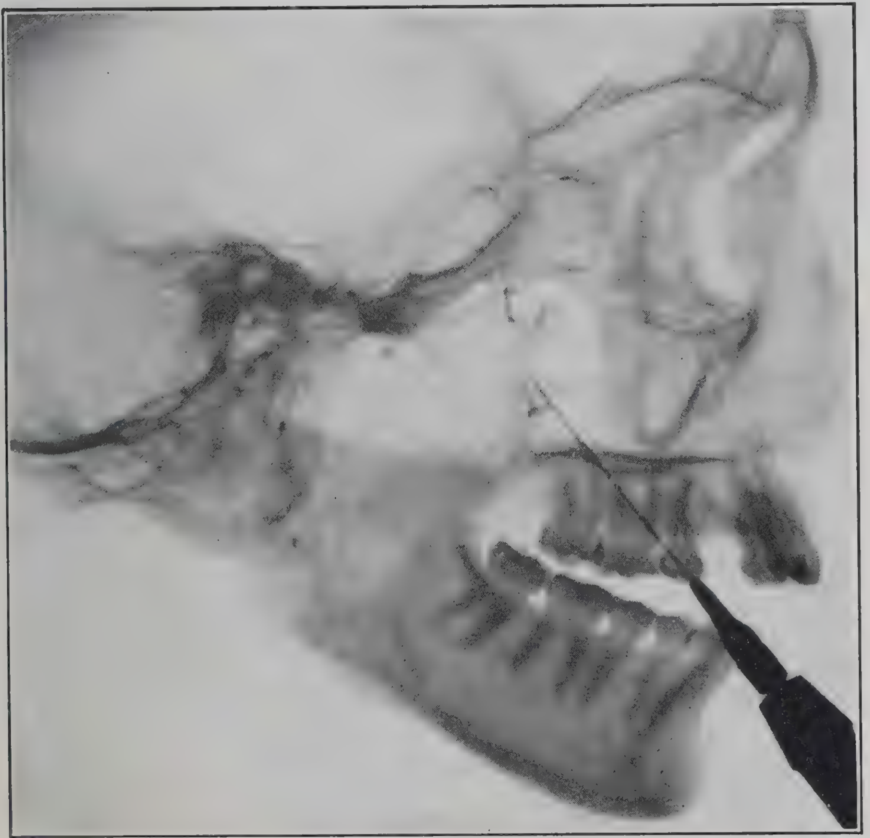


Fig. 55. Radiograph of wet specimen showing final position of needle in a tuberosity injection.

Anesthesia of the First Molar.

The tuberosity injection will not always anesthetize the anterior buccal root of the first molar tooth. This is due to the anastomosis of the middle superior alveolar nerve with the posterior. Sensation in this manner is carried from the middle superior alveolar nerve to the first molar tooth. Contrary to the writings of some teachers on the subject, the author has

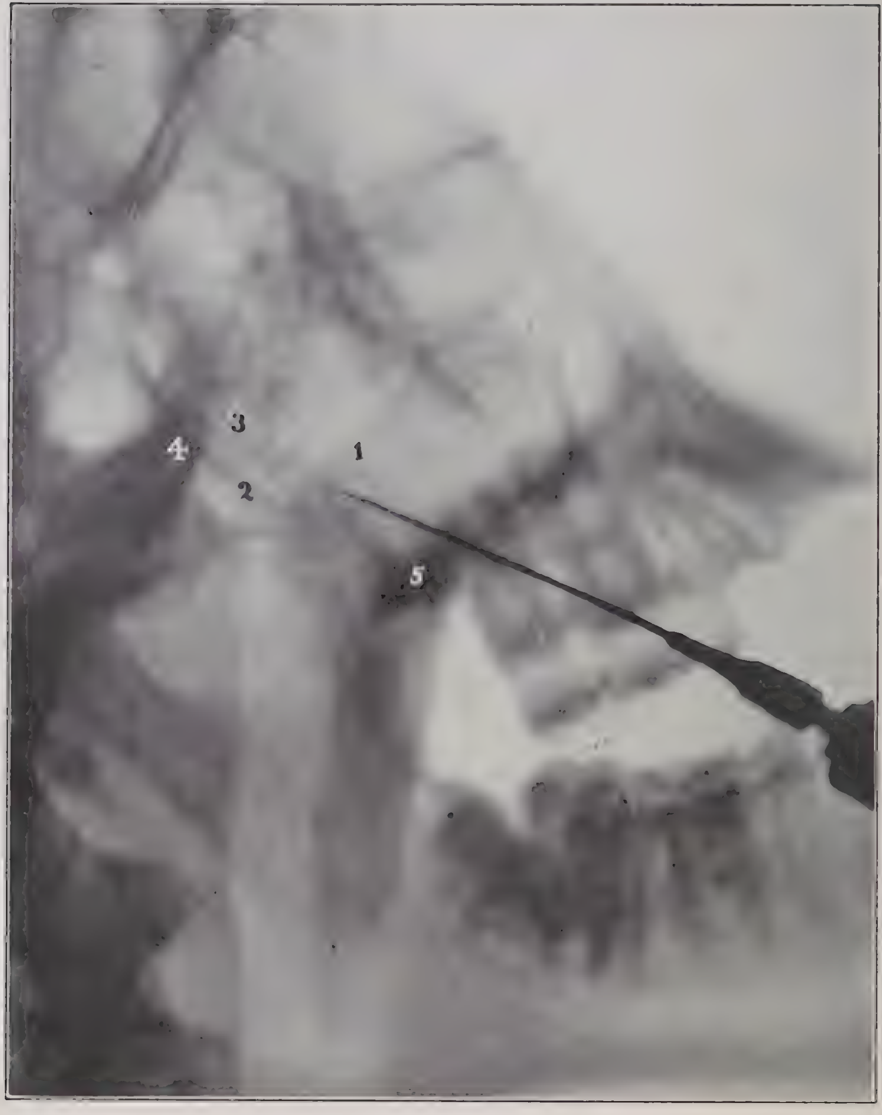


FIG. 56. Radiograph of patient showing final position of needle in a tuberosity injection. 1. Tuberosity of superior maxilla. 2. External pterygoid plate. 3. Pterygopalatine fossa. 4. Petrous portion of temporal bone. 5. Erupting third molar tooth.

never been able to anesthetize the middle superior alveolar nerve with a tuberosity injection, as this nerve is generally given off in the infraorbital canal and cannot be reached by this injection.

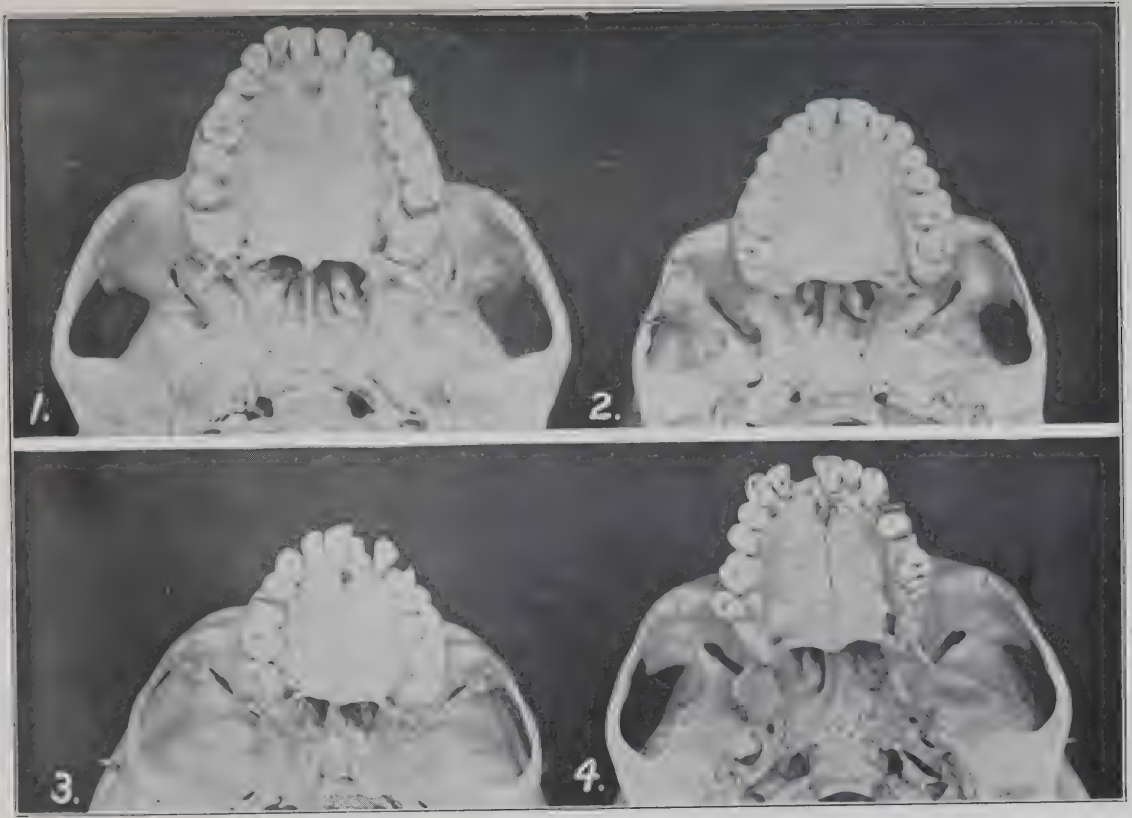


Fig. 57. Position of anterior and posterior palatine foramina. Note numerous small foramina on the palate. 1. Third molar tooth in position. 2. Third molar tooth not yet erupted. 3 Second molar tooth just erupted. 4 Third molar tooth extracted on right side. First and third molars extracted on left side.

To complete anesthesia of the first molar tooth, about ten drops of solution are injected subperiosteally over its anterior buccal root.

If the proper technique is carried out, profound anesthesia of the posterior superior alveolar nerve will take place within a few minutes and will last for about one hour. The area anesthetized will include the first, second and third molar teeth, their buccal alveolar plate, periosteum and mucous membrane.

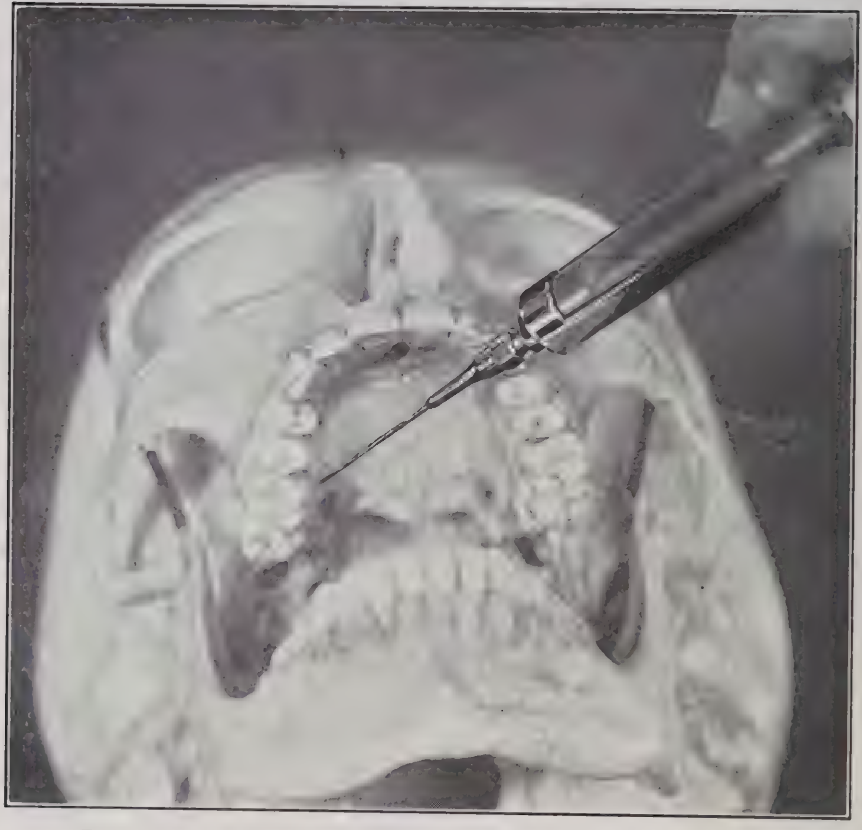


FIG. 58. Insertion of needle in a posterior palatine injection on the skull.

The Posterior Palatine Injection.

The tuberosity injection will suffice for those dental operations on the three upper molar teeth which do not involve their palatal investment, such operations as grinding teeth, preparation of cavities, extirpation of pulps, etc. For the extraction of these teeth, or any operation which involves the palatal alveolar plate and the soft structures covering same, the inner nerve loop must be anesthetized also. The anterior palatine nerve, entering the oral cavity at the posterior palatine foramen, innervates the palatal plate of the molars and bicuspids. This nerve must be anesthetized for complete anesthesia of the upper molars.

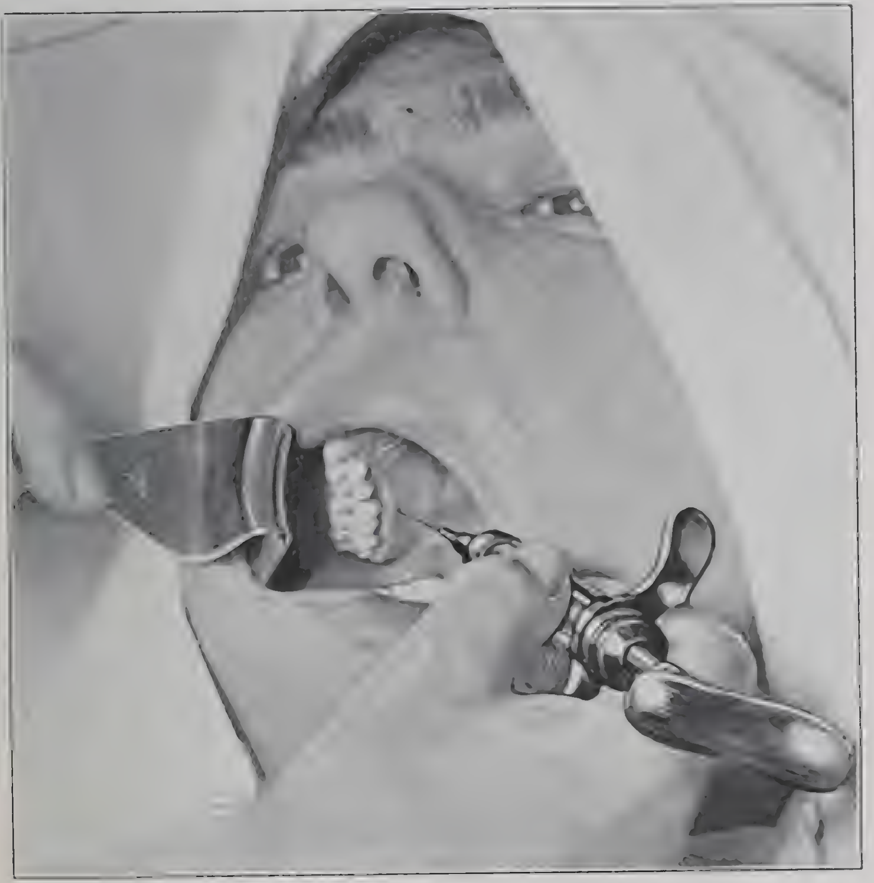


FIG. 59. Insertion of needle in a posterior palatine injection on the patient.

Needle Employed. For the posterior palatine injection a thinner and shorter needle should be used. The writer prefers a 25 mm. (1″) 23 gauge of either iridio-platinum or steel. The needle is inserted beneath the mucous membrane covering the hard palate. The underlying fibrous tissue is very tough and offers considerable resistance toward the progress of the needle. A too heavy gauge needle may, for this reason, produce too much trauma in this injection.

Landmarks. Again, the two last teeth of the patient are taken as a guide, depending entirely upon the eruption of these teeth and not upon whether they have been extracted or still remain in situ. (Fig. 57.) Supposing this is the same patient upon whom the tuberosity injection has been just completed, the technique would then be as follows:

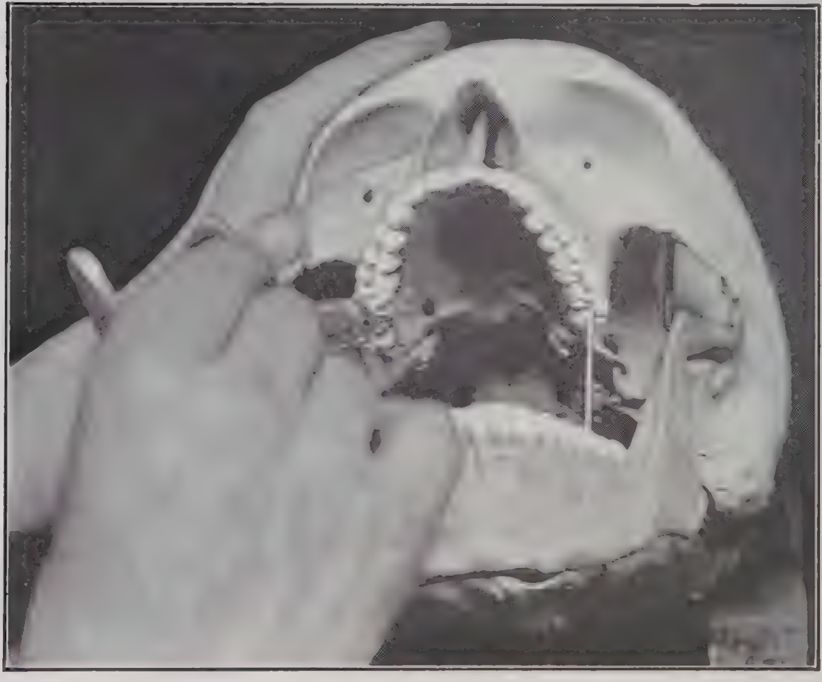


FIG. 60. Final position of needle in a posterior palatine injection on the skull.

Standing in front of the patient and holding the syringe in a pencil-like manner, the needle is inserted a quarter of an inch above the lingual gingival margin of the posterior third of the second molar tooth, the position of the syringe being between the cuspid and the first bicuspid on the opposite side. (Figs. 58, 59.) The mucous membrane is penetrated and the syringe is then brought to the same side of the injection, parallel to the alveolar plate and at an angle of about 45 degrees with the occlusal plane of the upper teeth. The needle is advanced beneath the mucous membrane over the root apices of the wisdom tooth until the needle is felt to enter the posterior palatine foramen. Here the anesthetic solution is slowly injected. (Figs. 60, 61, 62, 63 and 64.)

It is not absolutely essential for the needle to enter the foramen, for it will be remembered that the anterior palatine nerve and the artery lie in a groove formed by the junction of the alveolar and palatal processes; if the needle should strike this groove near the foramen, complete anesthesia will follow.

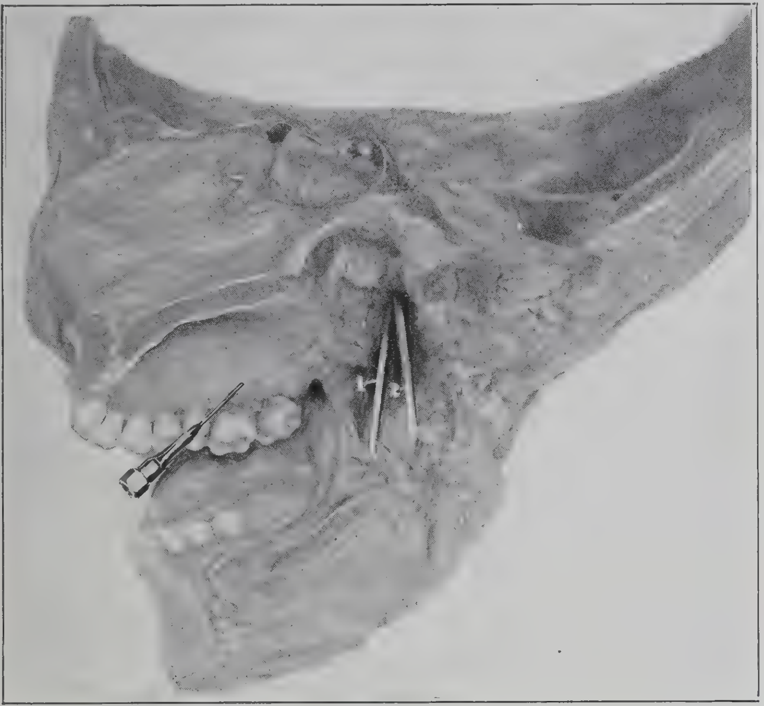


FIG. 61. Final position of needle in a posterior palatine injection on wet specimen (sagittal section.) The internal pterygoid muscle has been removed. 1. Lingual nerve. 2. Inferior dental nerve. (From a preparation by the author.)

From eight to ten drops of a 2 per cent procaine solution will suffice for this injection. The area anesthetized will be the palatal alveolar plate, periosteum and mucous membrane of the upper molar and bicuspid teeth as far anteriorly as the cuspid tooth. Anesthesia is established about one minute after the injection.

The position of the posterior palatine foramen is sometimes marked by a depression on the mucous membrane of the hard palate, located above and slightly posteriorly to the last erupted molar tooth. When this depression is discernible, the posterior palatine foramen may be entered easily by inserting the needle into this depression from the opposite side.

The needle is then brought parallel to the alveolar plate on the same side as the injection and the posterior palatine foramen entered, discharging the solution therein.

In this injection, the patient frequently experiences difficulty in deglutition, with an uncomfortable gagging sensation and a desire to expectorate. This may be due to the fact that the solution has been deposited either too far posteriorly or else too much solution has been injected. The accessory palatine foramina have been reached by the solution and the middle and posterior palatine nerves anesthetized, with the result that the soft palate, uvula and pillars of the fauces have been anesthetized. The muscles of the palate, particularly the tensor veli palati, and the levator veli palati are deprived of their sensory as well as motor nerve impulses, which may account for the difficult deglutition. (Fig. 65.)

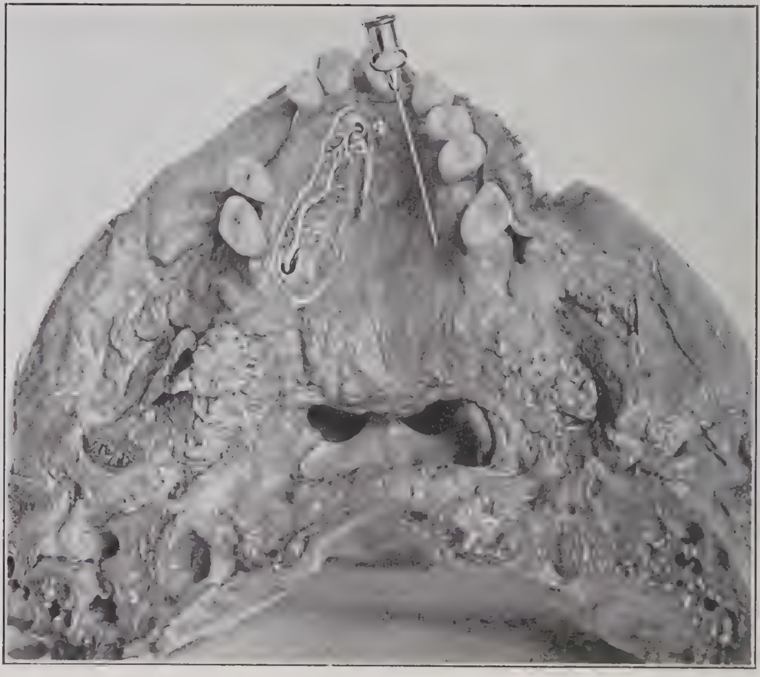


FIG. 62. Posterior palatine injection on a horizontal section of wet specimen. 1. Posterior palatine foramen. 2. Posterior palatine nerve. 3. Nasopalatine nerve. 4. Anterior palatine foramen. (From a preparation by the author.)

Frequently after a posterior palatine injection, partial anesthesia is observed not only in the anterior pillars but also in the upper portion of the palatine tonsils. This undoubtedly is due to the diffusion of the anesthetic solution and anesthetization of the middle and posterior palatine nerves which innervate that region.

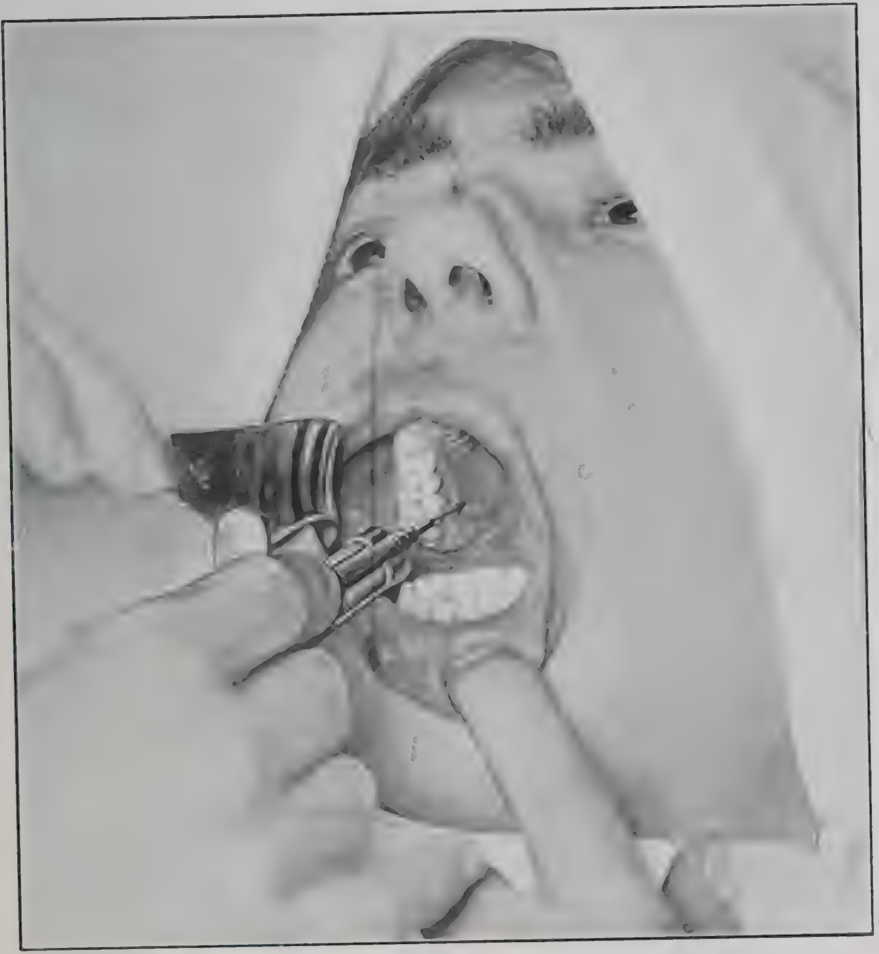


FIG. 63 Final position of needle in a posterior palatine injection on the patient

It is essential that the syringe be brought parallel to the alveolar plate on the same side as the injection, otherwise the needle may be engaged in the periosteum or be impeded by bone while on its way to the posterior palatine foramen. It will be observed that the foramen cannot be entered unless the needle is held parallel to the lingual alveolar plate.

To avoid anesthetizing the middle and posterior palatine nerves, care

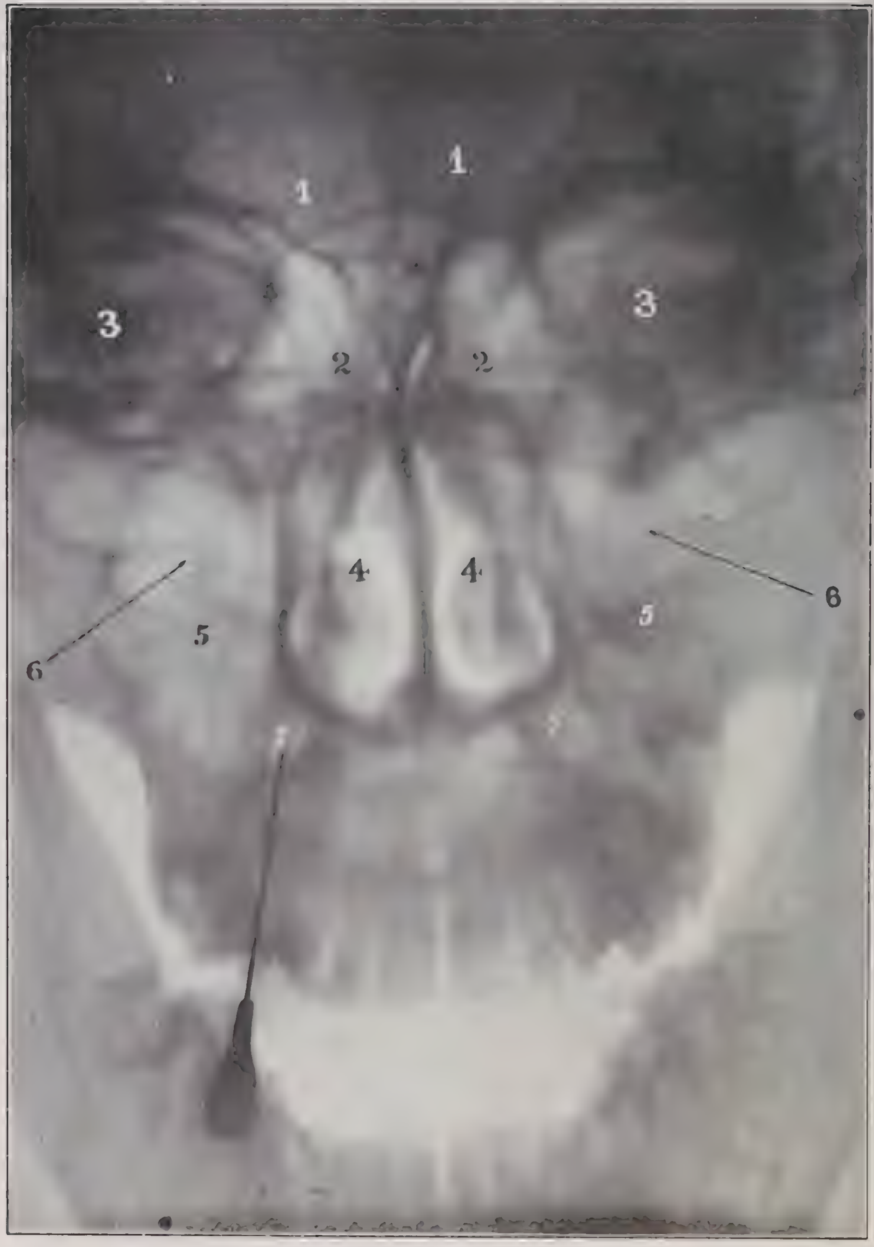


FIG. 64. Radiograph of patient showing final position of needle in posterior palatine injection. Note needle entering the posterior palatine foramen. 1. Frontal sinuses. 2. Ethmoidal cells. 3. Orbits. 4. Nasal cavities. 5. Maxillary sinuses. 6. Infraorbital foramina. 7. Posterior palatine foramina. 8. Anterior palatine foramen.

should be taken not to inject too much solution. Eight or ten drops will suffice to produce complete anesthesia as far anteriorly as the cuspid tooth.

The anterior palatine nerve anastomoses with the nasopalatine at the cuspid tooth. The two nerves, therefore, must be anesthetized in most cases to produce lingual anesthesia of the alveolar plate and mucous membrane of the cuspid tooth.

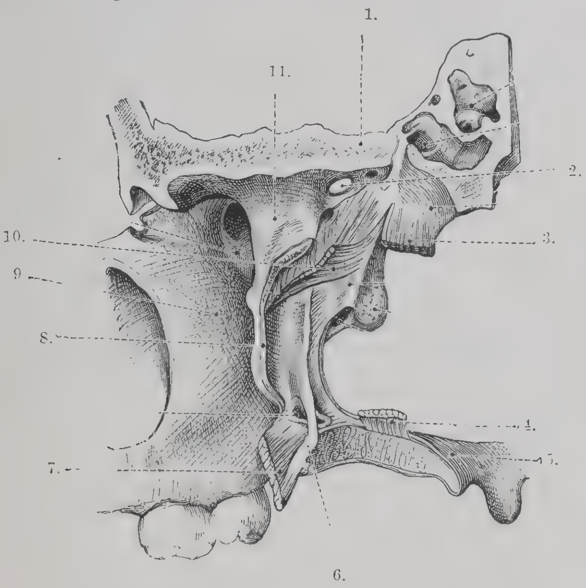


FIG. 65. Origin and insertion of tensor palati and levator palati muscles. In a posterior palatine injection these muscles are sometimes anesthetized. This may account for difficult deglutition. 1. Spinous process of sphenoid bone. 2. Foramen ovale. 3. Origin of levator palati muscle. 4. Insertion of levator palati muscle. 5. Soft palate. 6. Hamular process. 7. Insertion of tensor palati. 8. Cut edge of external pterygoid plate. 9. Tuberosity. 10. Tensor palati. 11. Pterygoid process. (From Toldt's Anatomy.)

Anesthesia of the Entire Outer Nerve Loop.

When we examine and compare the infraorbital canal with the mandibular, we are impressed by the similarity in their structure and relationship to the innervation of the upper and lower teeth. The source of nerve supply of the lower teeth is the inferior dental nerve within the mandibular canal. The source of nerve supply of the upper teeth is the infraorbital nerve located within the infraorbital canal. We anesthetize all the lower teeth on one side by blocking the inferior dental nerve at the mandibular sulcus. In a similar manner, if we were to block the infraorbital nerve before the posterior, middle and anterior superior alveolar nerves are given off, all the upper teeth would be anesthetized. (Fig. 66.)

This may be accomplished by depositing the solution at the posterior termination of the infraorbital canal before the infraorbital nerve enters the infraorbital groove. Therefore this injection we will term the *posterior infraorbital.* On the other hand, the anesthetic solution may be deposited at the anterior termination of the infraorbital canal, the infraorbital foramen, and the solution driven through the infraorbital canal. This injection we shall term the *anterior infraorbital.* We shall describe the latter injection first.

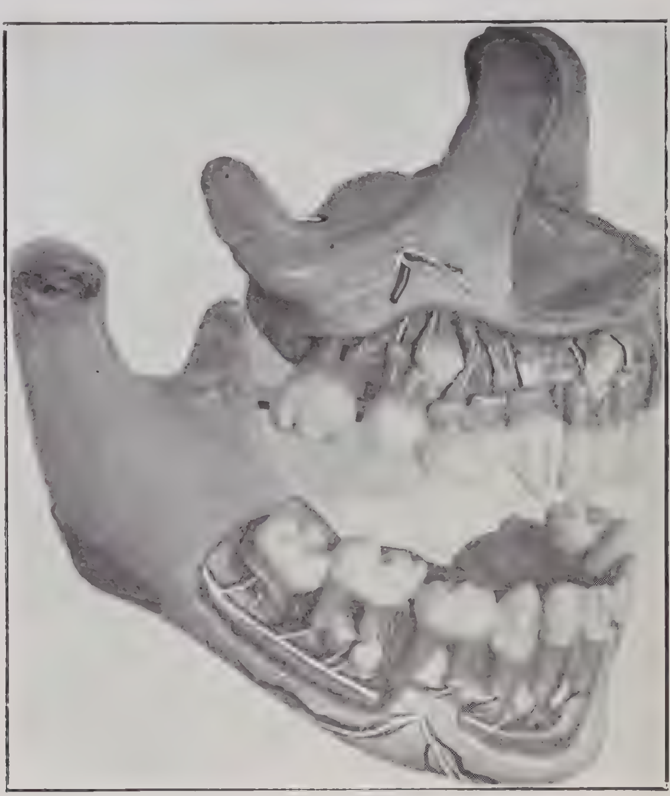


Fig. 66. Position and location of infraorbital nerve, supplying the upper teeth and the inferior dental nerve, supplying the lower teeth. (From the collection of the author.)

Anterior Infraorbital Injection.

The anterior infraorbital injection may be regarded as next in importance to the mandibular. Many operators, however, find it more difficult to obtain anesthesia with this injection than any other and for this reason they frequently abandon it entirely. Symptoms may be manifested after this injection which would lead the anesthetist to presume that the desired results have been obtained, only to be bitterly disappointed later when beginning to operate. There is very frequently a pronounced numbness on the side of the nose, upper lip and lower eyelid, due to the anesthetization of the terminal branches of the infraorbital nerve, namely, the nasal, labial and palpebral. The solution, however, not having been carried high enough, did not enter the infraorbital canal and therefore did not even reach the anterior superior alveolar nerve, thereby failing to anesthetize the central, lateral and cuspid teeth. It must be remembered that the anterior superior alveolar canal originates not at the infraorbital foramen but about 6 mm. (¼″) posteriorly; in order then to enable the solution to reach the anterior superior alveolar nerve, it must be deposited as near the infraorbital foramen as possible.

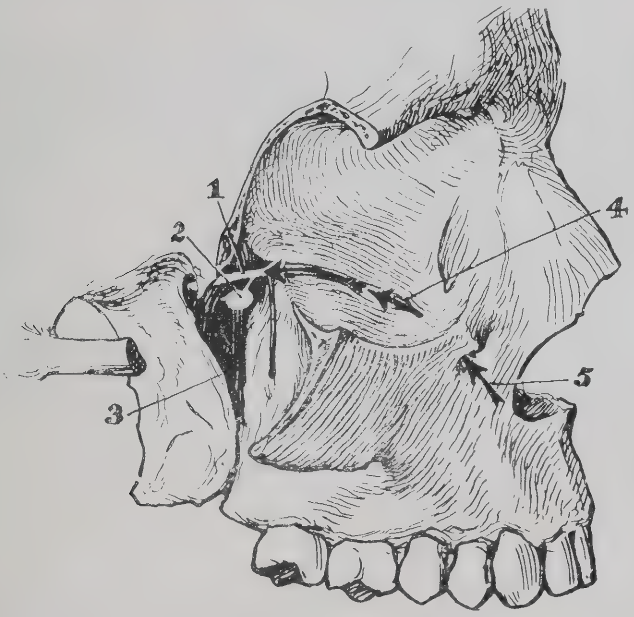


Fig. 67. Arrows indicating direction of the solution when injected into the infraorbital foramen. 1. Superior maxillary nerve. 2. Meckel's ganglion. 3. Anterior middle and posterior palatine nerves. 4. Infraorbital canal. 5. Infraorbital foramen.

With this injection, when the technique has been properly carried out, not only the anterior superior alveolar nerve may be anesthetized but also the middle, and in a great many cases the posterior as well. In other words, the entire outer nerve loop may be reached. Not only that, but in some cases the writer has succeeded in anesthetizing even the inner nerve loop at the same time, thereby obtaining complete anesthesia of all the upper teeth on the side of the injection, facially as well as palatally.

How the Solution Travels.

This can easily be demonstrated by an experiment on the dry skull. If we insert the needle into the infraorbital foramen, place the bulb of the index finger over the foramen and then eject the solution, we will find that the solution will pass through the infraorbital canal and reach the infratemporal and pterygopalatine fossæ. This is exactly what happens in a patient when we enter the infraorbital foramen. The bulb of the finger, held tightly over the foramen, prevents the solution from diffusing into the canine fossa and causes it to travel, propelled by the

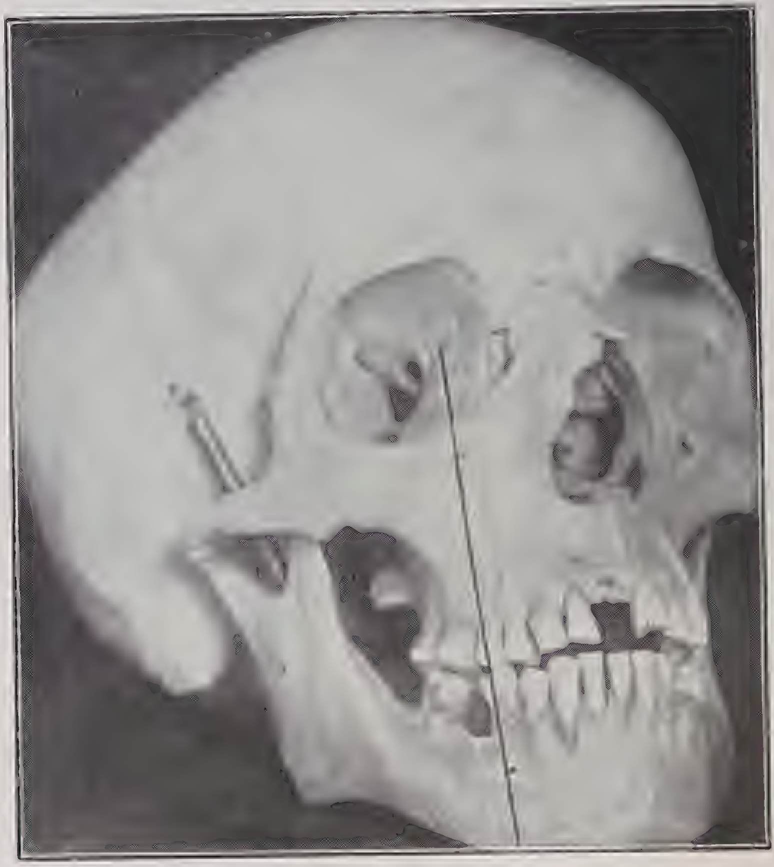


Fig. 68. Line drawn from pupil of eye to the long axis of second bicuspid tooth will cross the infraorbital and mental foramina.

pressure from the syringe, along the path of least resistance, namely the infraorbital canal. The anterior, middle and posterior superior alveolar nerves are anesthetized and the solution, by diffusing into the pterygopalatine fossa, may sometimes even reach Meckel's ganglion, anesthetizing the inner nerve loop also. (Fig. 67.)

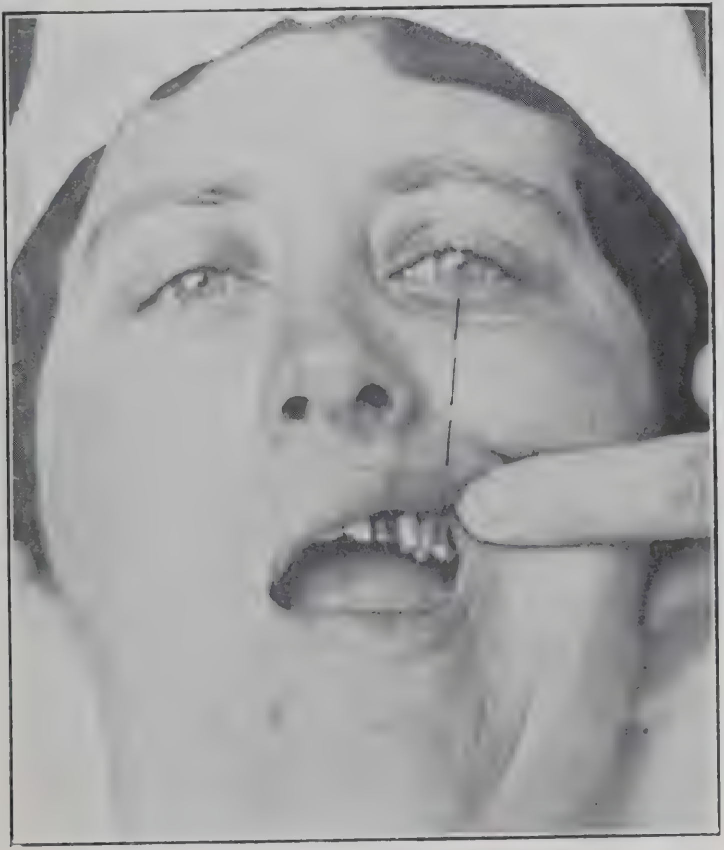


FIG. 69. Imaginary line drawn in an infraorbital injection from the pupil of the patient's eye to the long axis of the second bicuspid tooth. The infraorbital foramen will be found on this line slightly below the infraorbital ridge.

The examination of the superior maxilla will reveal to us the concave canine fossa, bounded above by the infraorbital ridge and below by the alveolar process. The infraorbital foramen will be found on an imaginary line drawn from the center of the orbit to the long axis of the second bicuspid tooth. It is evident that in order to reach the infraorbital foramen the needle must be kept away from bone (the floor of the canine fossa), and must be directed on a straight line from the second bicuspid tooth to the center of the orbit, which corresponds to the pupil of the patient's eye. (Fig. 68 and 69.)

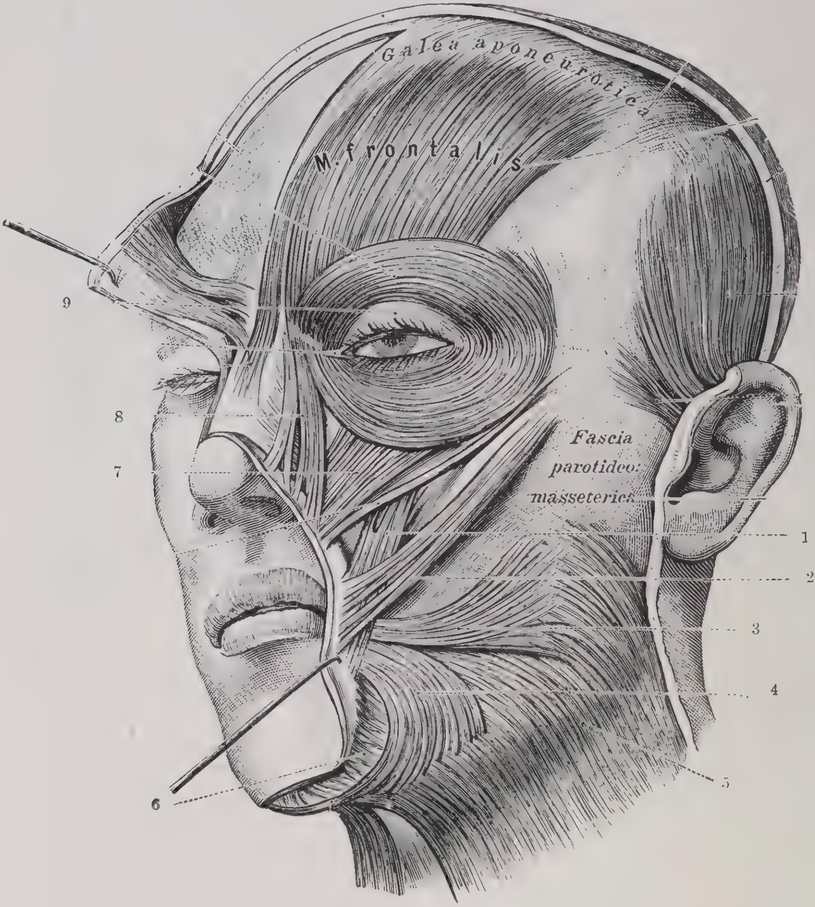


FIG. 70. Muscles of facial expression. The two muscles, the caninus and the caput infraorbitale, are frequently injected in an anterior infraorbital injection. 1. Caninus muscle (levator anguli oris). 2. Zygomaticus major. 3. Risorius. 4. Depressor anguli oris. 5. Platysma myoides. 6. Depressor labii inferioris. 7. Caput infraorbitale (levator labii superioris). 8. Caput angulare. 9. Orbicularis palpebrarum. (From Toldt's Anatomy.)

Muscles to be Avoided.

In this injection, just as in a tuberosity or mandibular, a muscle must be carefully avoided. In this instance it is the caninus (levator anguli oris) which fills the canine fossa. Another muscle to be considered is the caput infraorbitale (levator labii superioris) which arises from the infraorbital ridge. If the needle be kept close to bone, the caninus muscle will be infiltrated. Should it be directed too far externally from bone the caput infraorbitale may be entered. In either case edema and ecchymosis may result. (Fig. 70.)

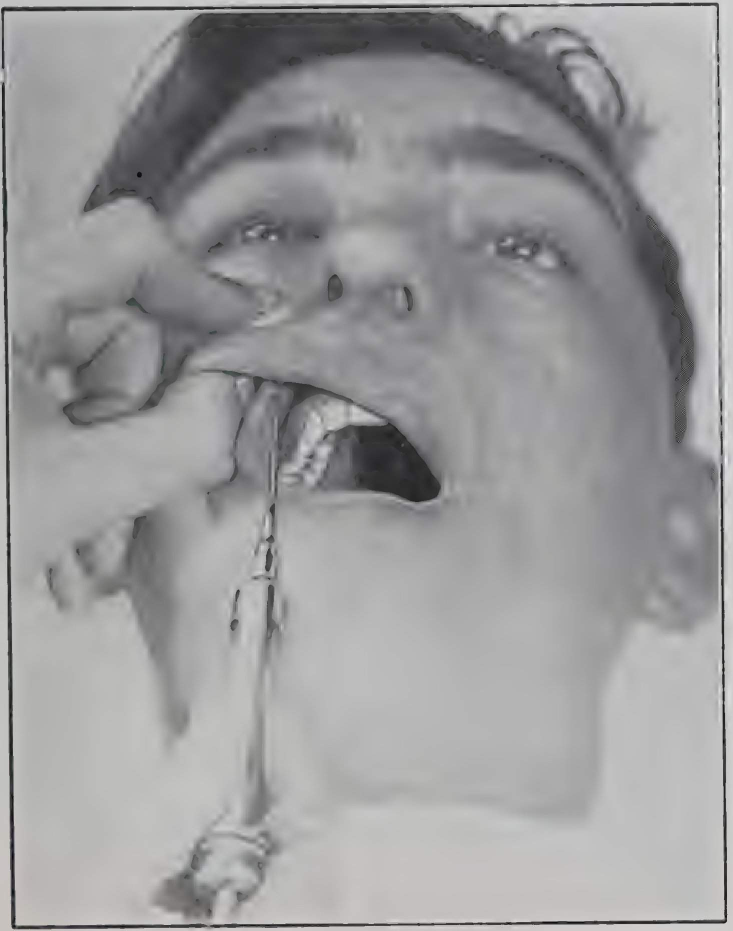


FIG. 71. Position of the index finger and thumb in an anterior infraorbital injection. Insertion of needle into the reflection of mucous membrane, slightly away from bone.

Technique.

The technique of the anterior infraorbital injection is as follows: An imaginary line is established from the pupil of the patient's eye to the long axis of the second bicuspid tooth. The operator must always be guided by this line in this injection. The writer has seen many men, after mentally determining the line and obtaining the proper position, proceed with the injection, ignoring the line entirely.

Standing in front of the patient, the infraorbital ridge is first palpated and then the infraorbital foramen, which will be found slightly below the infraorbital ridge, on the imaginary line. The bulb of the index finger is placed on the infraorbital foramen and the lip raised with the thumb. The two fingers are kept in this position throughout the entire injection. (Fig. 71.) With a little practice, the anesthetist will learn how to correctly palpate and find the infraorbital foramen and know at once when it is located. The foramen is marked by a distinct depression into which the bulb of the index finger seems to sink. A little externally or internally from this depression the elevation of the infraorbital ridge may be easily felt with the palpating finger. On

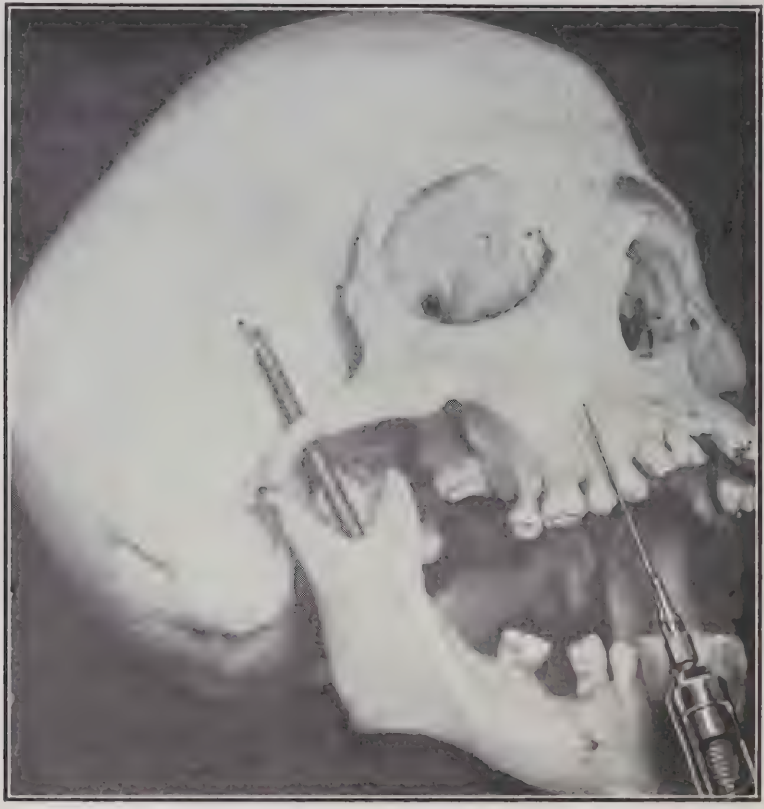


Fig. 72. Insertion of needle in an anterior infraorbital injection shown on skull.

putting pressure over the infraorbital foramen a sharp sensation of pain will be experienced by the patient due to pressing the infraorbital nerve against the bony ridge around the foramen.

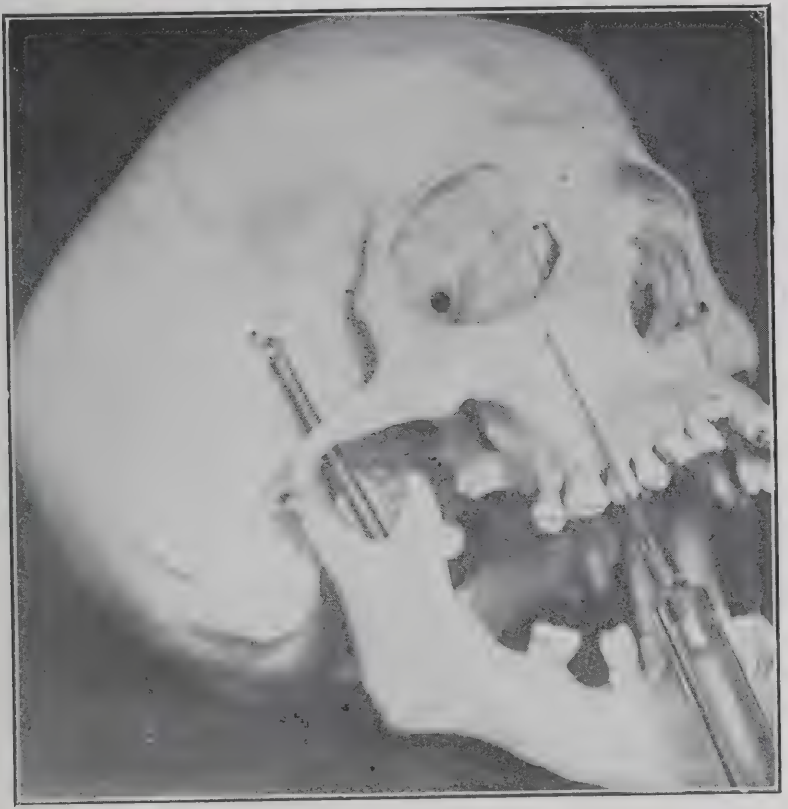


FIG. 73. Final position of needle in an anterior infraorbital injection on skull. Needle striking the under surface of the infraorbital ridge.

The 42 mm. (1⅝″) 21 gauge needle, of either platinum or steel, is used. The mucosa above the second biscuspid tooth, at the reflection of the mucous membrane, is painted with tincture of iodin. The syringe is then picked up like a pencil and the needle inserted into the reflection of the mucous membrane, as high as possible, and slightly away from bone. The needle is directed in the established imaginary line. The needle, directed thus, will clear the canine fossa and the caninus muscle and will glide in a layer of fat between the caninus and caput infraorbitale. The syringe should rest on the patient's lower lip in order to avoid striking the floor of the canine fossa. (Figs. 71, 72.) The needle is then gradually and cautiously advanced, injecting a few drops on the way, so as to have a painless path in front of the needle. The two fingers are kept continuously in the same position, namely, the index finger at the infraorbital foramen and the thumb lifting the lip. The needle is progressed upward on the visualized line toward the pupil of the eye until the ejected anesthetic solution is felt beneath the palpating finger. If it is our intention to anesthetize only the three anterior teeth, the solution may be injected slowly at this point. If, however, we contemplate anesthetizing the bicuspids and even the molars, the needle should be carried still higher until the point gently strikes bone. If the needle has been properly directed, it will strike the under surface of the in-

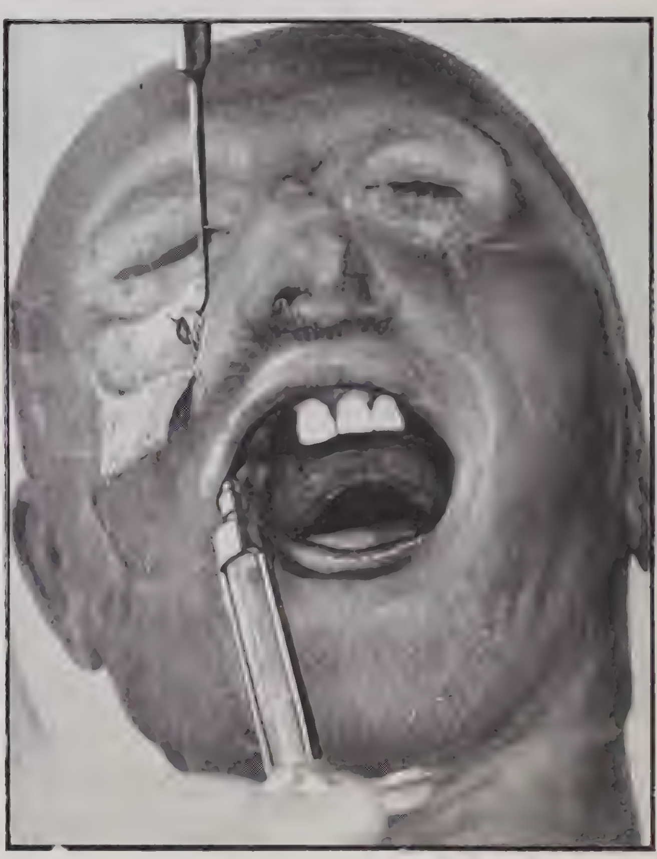


FIG. 74. Final position of needle in an interior infraorbital injection on wet specimen. Note infraorbital plexus of nerves.

fraorbital ridge and not the floor of the canine fossa and will be either in the infraorbital foramen or in its close proximity. The solution is slowly injected here and may be driven either directly into the infraorbital canal or by diffusion it will reach the canal and anesthetize the anterior superior alveolar, middle and in a number of cases, the posterior superior alveolar nerves. (Figs. 73, 74, 75, 76, 77 and 78.)

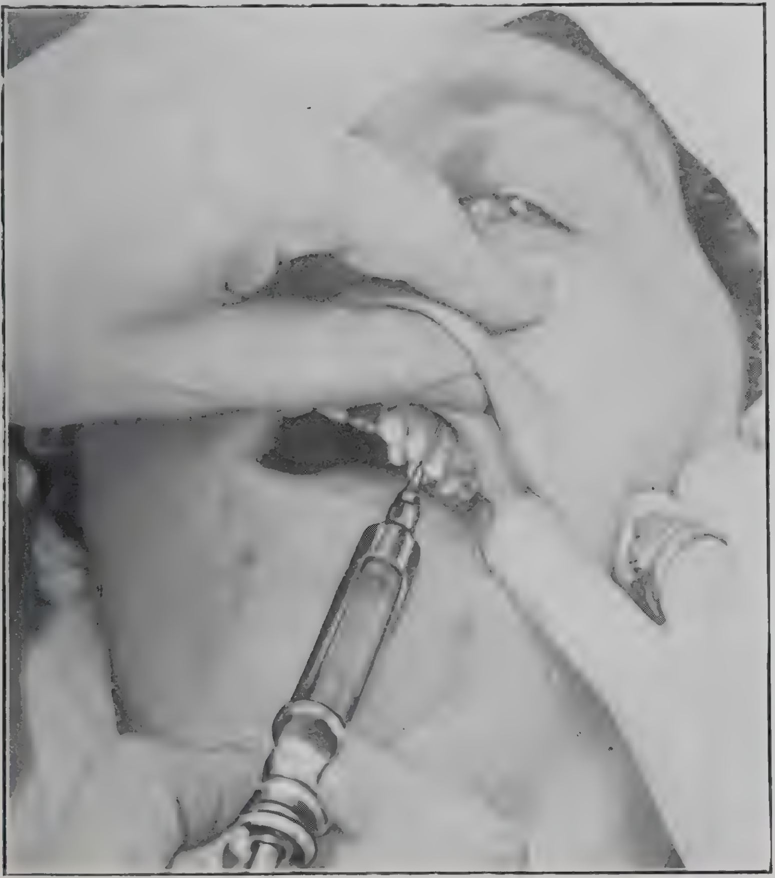


FIG. 75. Final position of needle in an anterior infraorbital injection on patient.

Direction of Needle.

The initial insertion and direction of the needle will generally determine the success of the injection. If the syringe does not rest upon the patient's lower lip, but is away from it, the needle will strike the floor of the canine fossa and the solution will be injected into the caninus muscle. If the needle is directed not on the imaginary straight line but in a slightly inclined plane medially or distally, when in the final position, the needle will be away from the infraorbital foramen. This is illustrated in diagram in Figs. 79 and 80.

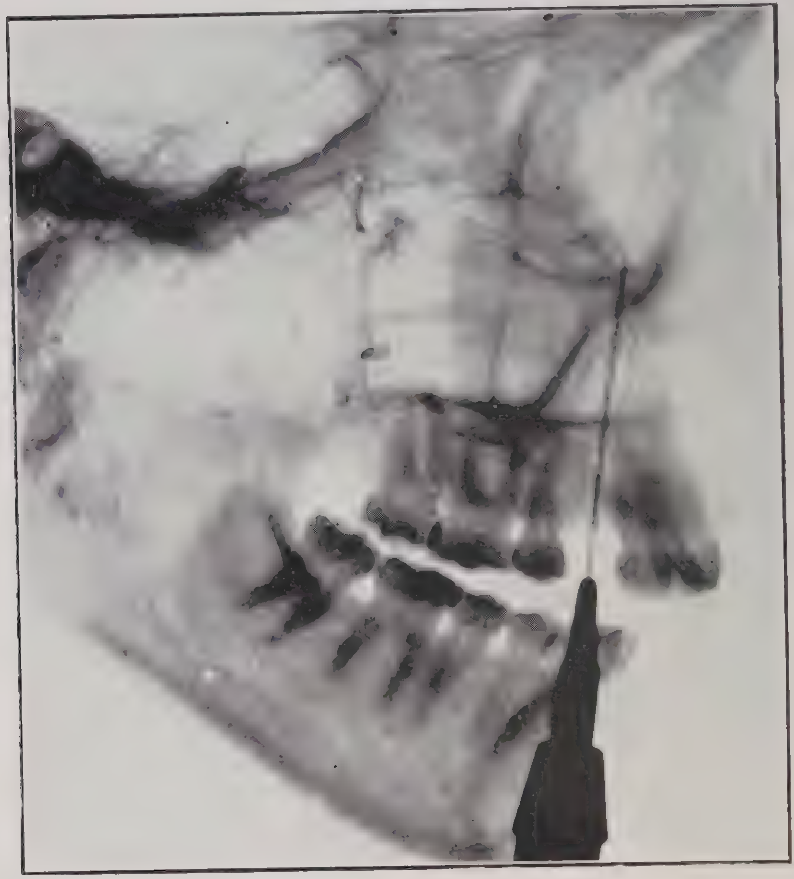


FIG. 76. Lateral radiograph of wet specimen showing final position of needle in an anterior infraorbital injection.

Symptoms. After the injection, the cheek over the infraorbital foramen is massaged with an upward motion to drive the anesthetic solution into the infraorbital canal.

As explained before, the numbness on the side of the nose and upper lip is not always indicative of a successful injection. This condition is due to the anesthetization of the nasal and labial branches of the infraorbital nerves, and it does not necessarily mean that the anterior superior alveolar nerve has been anesthetized. These terminal branches may be reached when the solution is deposited into the canine fossa.

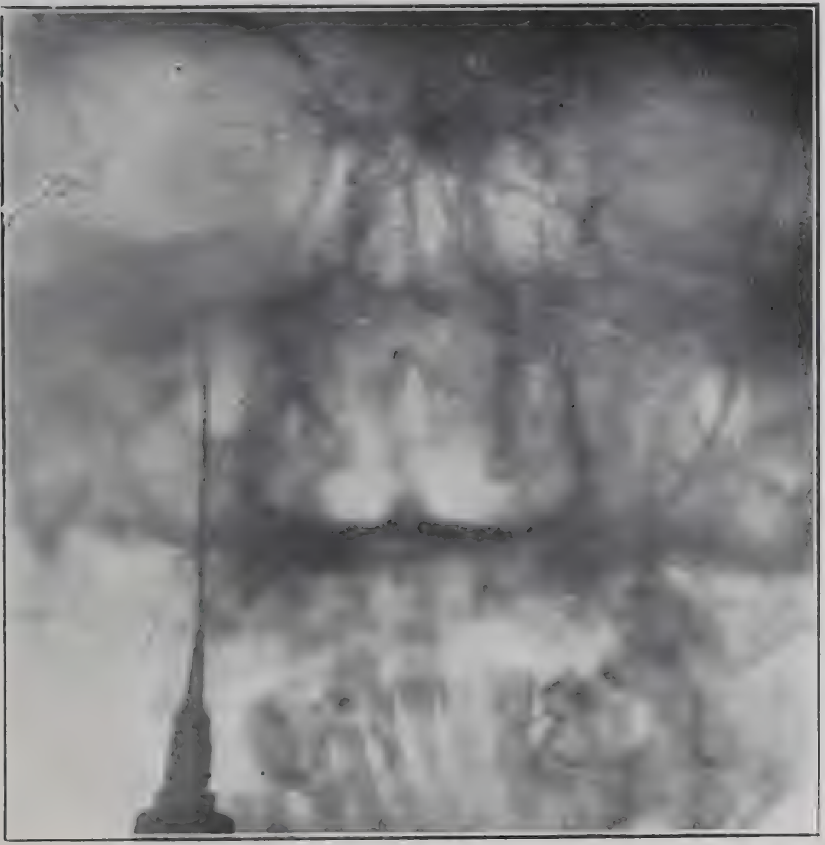


FIG. 77. Antro-posterior radiograph of wet specimen, showing needle entering the infraorbital foramen.

The drooping of the upper lip on the side of the injection may be considered a good symptom. This is due to the anesthetization of the terminal branch of the temporofacial division of the facial nerve at the infraorbital plexus, and would indicate that the solution has been deposited at the infraorbital foramen. This same symptom in a mandibular injection should be considered unfavorable, inasmuch as the injection has been made too far posteriorly and the cervicofacial division of the facial nerve has been anesthetized in the parotid gland. In either case the motor nerve control of the upper lip is lost. This accounts for the characteristic appearance of the lip. (Fig. 81.)

Testing. The mucosa is tested for anesthesia by compression with a pair of pliers. If the injection has been properly made, the anesthetist will be agreeably surprised to find almost immediate anesthesia of the anterior superior alveolar nerve. This is best tested over the lateral incisor tooth, as the central incisor is also innervated by anastomosis from the opposite infraorbital nerve. The anesthesia of the bicuspids will follow either immediately afterwards or a few minutes later. If the molars are to be operated on, the mucous membrane slightly above the gingiva of either of the first or second upper molar tooth should be tested. When there is no response to pressure it serves as an indication that the posterior superior alveolar nerve has also been anesthetized.

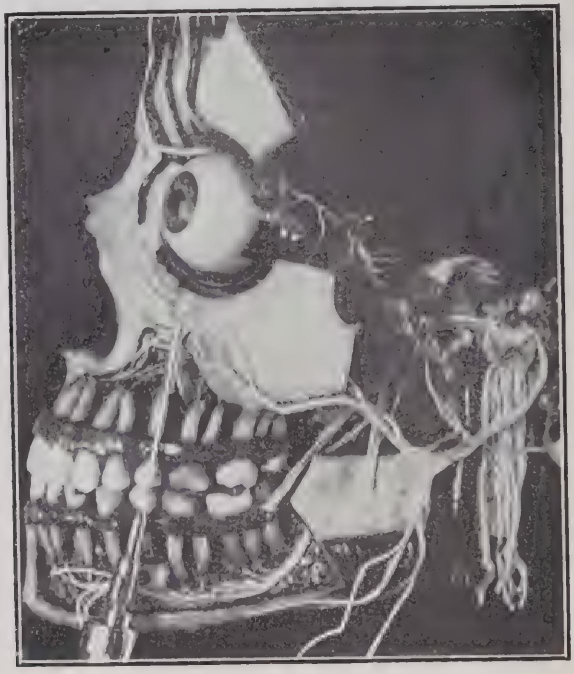


Fig. 78. Position of needle in an anterior infraorbital injection on prepared anatomical specimen.

One point should be borne in mind in testing for anesthesia in the upper molars. While there may be no pain whatever slightly above the gingival margin, yet when the mucous membrane is tested higher, at its junction with the alveolar plate, there may be sensation of pain. This phenomenon is due to the innervation of the buccal mucous membrane by the long buccal nerve. The posterior superior alveolar nerve appears to supply that part of the buccal mucous membrane immediately above the gum margin while the long buccal nerve supplies the reflection of the mucous membrane where the buccinator muscle is inserted into the buccal alveolar ridge. The fibers of the long buccal nerve may be anesthetized by infiltration by injecting about 5 or 10 drops of the anesthetic solution into the buccinator muscle attachment above the molar tooth to be operated on.

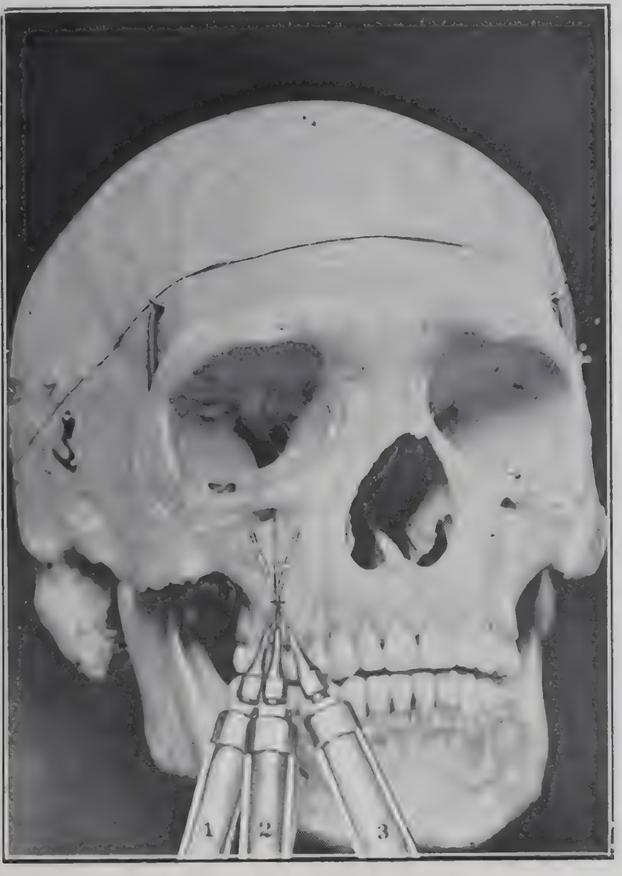


Fig. 79. Correct and incorrect directions of needle in an anterior infraorbital injection. 1. Needle incorrectly directed medially. 2. Needle directed correctly on a straight line. 3. Needle incorrectly directed distally.

It may be apropos to remark that the terminal filaments of the long buccal nerve, which innervate the buccal mucous membrane of the three upper molar teeth, are anesthetized in a tuberosity injection at the time the needle is inserted into the reflection of the mucous membrane at the posterior third of the second molar tooth and while the solution is being injected on the way to the posterior superior alveolar foramen and nerve.

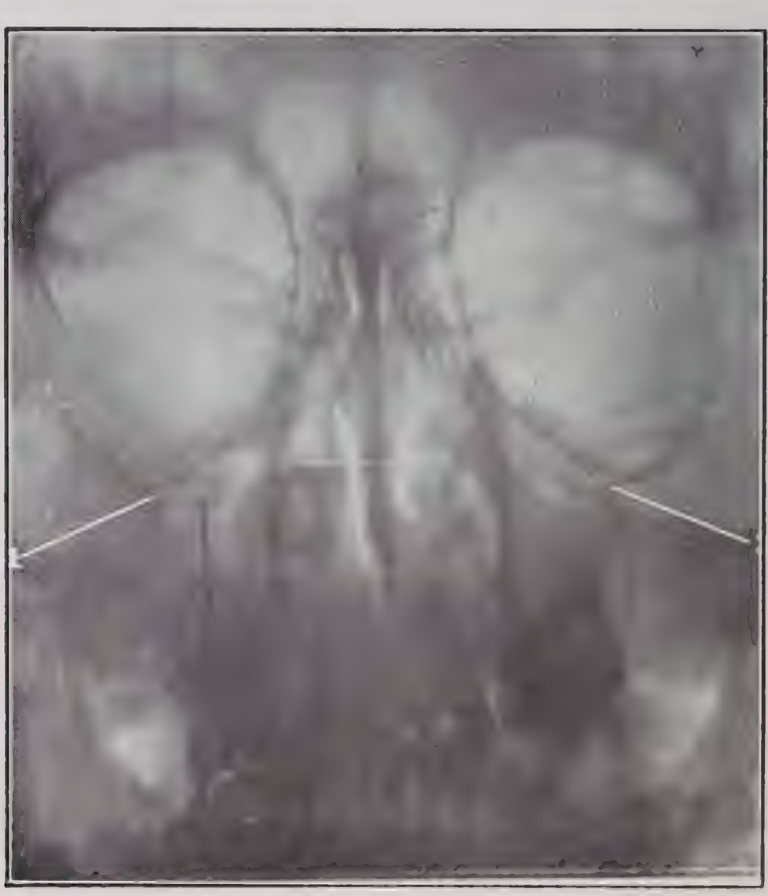


Fig. 80. Radiograph of needle in an anterior infraorbital injection on patient. Needle directed too far medially and infraorbital foramen was missed. Anesthesia was obtained in this case only in the anterior teeth and partial anesthesia in the bicuspids. 1. Infraorbital foramina.

Palatal Anesthesia.

After testing the facial and buccal mucous membrane, the lingual mucosa is tested to determine whether the inner nerve loop has been anesthetized. As explained before, in a number of cases the solution will be forced through the infraorbital canal and into the pterygopalatine fossa, reaching and anesthetizing Meckel's ganglion.

Caution in testing should be exercised here. The lingual and palatal mucous membrane of the upper teeth does not seem to be as plentifully supplied with afferent sensory nerve filaments as is the facial and buccal; therefore it is not always so responsive to stimulation. A good method of determining whether lingual anesthesia has been obtained is to test the opposite unanesthetized side and then compare the difference in response.

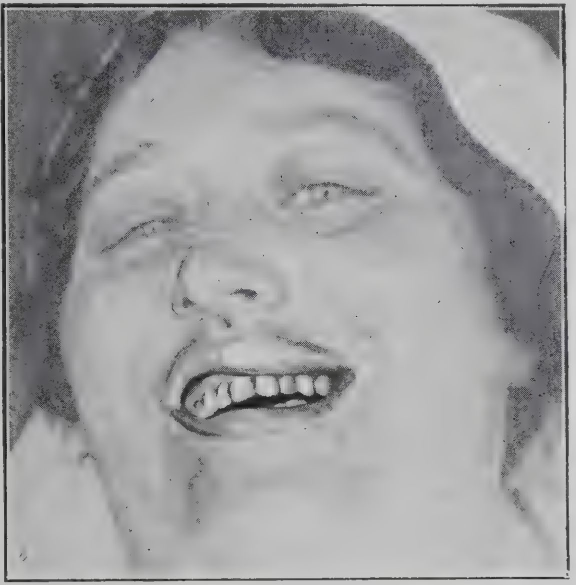


FIG. 81. Characteristic appearance after a successful anterior infraorbital injection. Drooping of the lip on the side of injection due to anesthetization of terminal branches of the temporofacial division of the facial nerve.

If lingual anesthesia has not been obtained, then the anterior palatine nerve for the bicuspids and molars and the nasopalatine nerve for the central, lateral and cuspid teeth must be anesthetized. The former is anesthetized by a posterior palatine injection, the technique of which has been described. The latter is anesthetized by an anterior palatine or incisive injection.

Anterior Palatine Injection.

The two nasopalatine nerves, it will be remembered, are located in the foramina of Scarpa, then passing through the anterior palatine foramen into the oral cavity they run, one on each side, to join the anterior palatine nerves at the cuspid teeth. It will be remembered also that the two foramina of Scarpa, together with the two foramina of Stenson, form the anterior palatine foramen. This accounts for the difficulty often encountered when endeavoring to enter the anterior palatine foramen with the needle. Another point of importance to remember is that the anterior palatine foramen runs parallel with the facial alveolar ridge, so that in order to enter the foramen the needle must be directed parallel to the facial alveolar plate of the central incisor teeth.

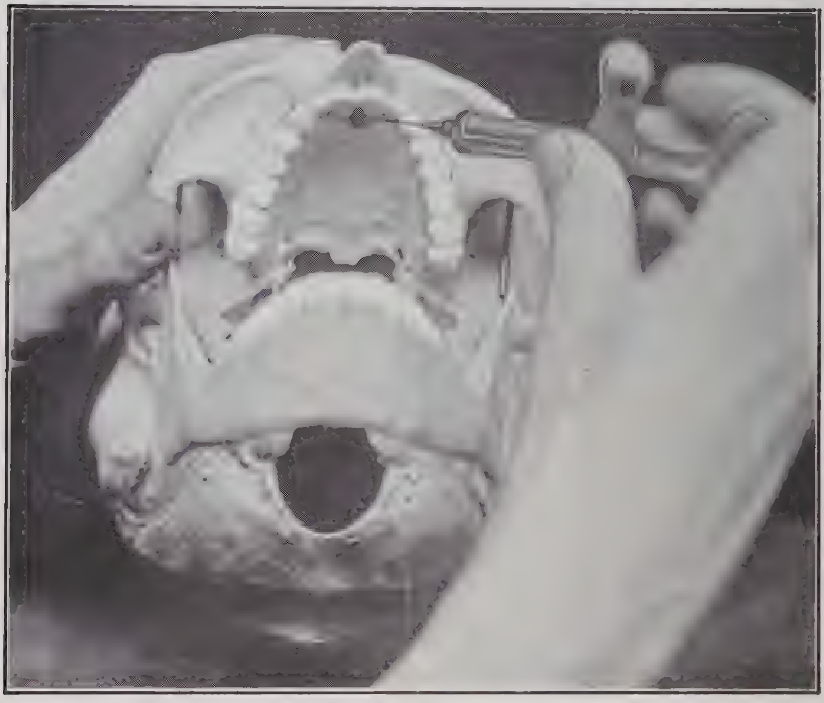


Fig. 82. Insertion of needle in an anterior palatine (incisive) injection on skull.

The opening of the anterior palatine foramen corresponds to a little elevation slightly posterior to the median space between the two central teeth. This elevation or papilla is extremely sensitive, so the insertion of the needle into this papilla is quite painful.

Technique. The technique of the anterior palatine injection is as follows: A 25 mm. (1″) 23 gauge needle, of either platinum or steel, is used for this injection. The patient's head is thrown back as far as possible, and the operator stands in front of the patient, slightly to the right.

The mucosa is painted with a 7% iodin solution, the syringe is picked up in a pencil-like manner and the needle inserted laterally to the papilla in order to avoid giving the patient unnecessary pain. A few drops of the anesthetic solution are here deposited. (Figs. 82, 83 and 84.) After the lapse of about one minute the position of the syringe is shifted, so the needle will be in a line between the two central incisor teeth and parallel with the long axis of the anterior teeth. The needle is inserted into the papilla and the anterior palatine foramen sought. Entering the foramen for a short distance, the solution is slowly discharged, depositing about ten drops of a 2% procaine solution. To obtain complete anesthesia of the nasopalatine nerve, the anterior palatine foramen must be entered, else the injection will fail. (Figs. 85, 86 and 87.)

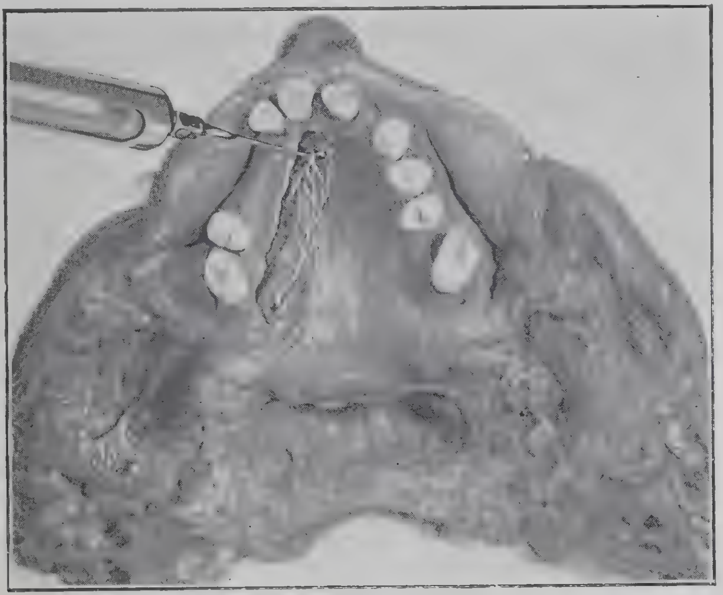


Fig. 83. Insertion of needle in an anterior palatine injection shown on wet specimen.

Palatal Anesthesia of Cuspid.

The palatal alveolar plate and the mucous membrane of the cuspid tooth are anesthetized most easily by infiltration. It must be remembered that the nasopalatine and anterior palatine nerves meet and anastomose in the cuspid region, so the anterior palatine nerve may carry sensation by anastomosis even though the nasopalatine nerve has been anesthetized. In cases of infection, when injection into the lingual mucous membrane of the cuspid tooth is precluded, the anterior palatine injection is made and lingual anesthesia tested for. In case of pain the posterior palatine injection is made also in order to block the anastomosis. This will invariably not only complete the anesthesia of the lingual aspect of the canine but will anesthetize the entire inner nerve loop on the palate on the side injected.

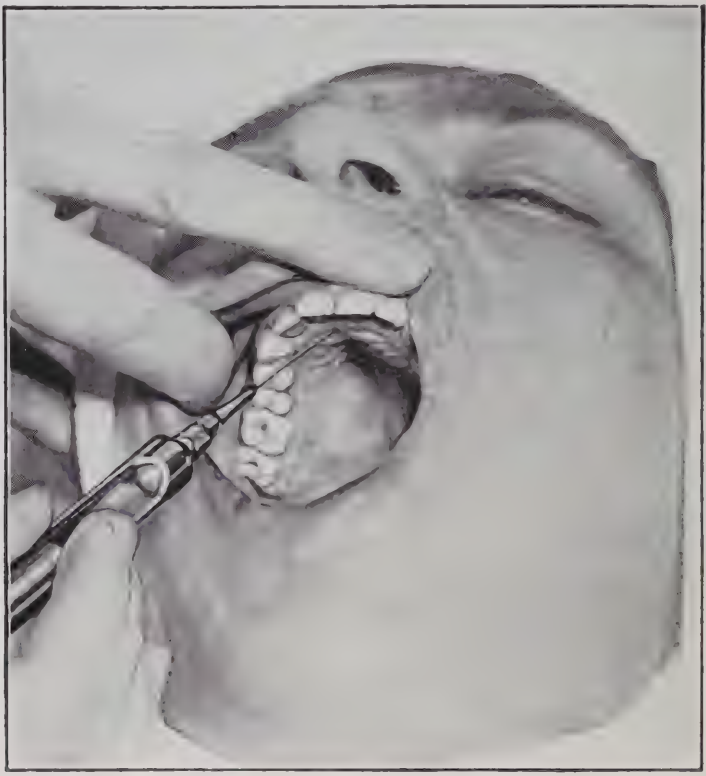


Fig. 84. Insertion of needle in anterior palatine injection on patient.

When an Anterior Infraorbital Injection Is Indicated.

The determination that an anterior infraorbital injection is to be made depends entirely upon the area to be operated on. If a patient presents with molars to be removed, the tuberosity and posterior palatine injections are indicated.

If the operation is to be performed on the anterior teeth or bicuspids, an anterior infraorbital injection should be resorted to. The bicuspid teeth will usually be anesthetized with a properly executed anterior infraorbital injection.

When a patient presents for the extraction of some anterior teeth, a bicuspid and molars on one side, our first thought should be an anterior infraorbital injection. After a 5 to 10 minute waiting period the extent of the anesthesia obtained should be determined. If anesthesia in the molar teeth has been obtained, lingual anesthesia should be tested for. Failing to anesthetize the inner nerve loop, either the posterior or anterior palatine injection, or both, should be made, depending, of course, upon the area which we wish to anesthetize.

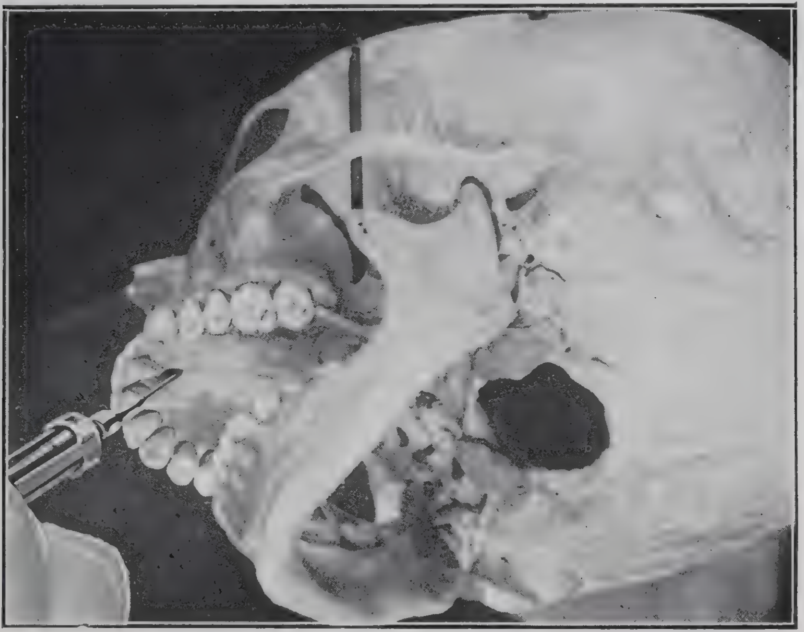


Fig. 85. Final position of needle in an anterior palatine injection on skull. Note position of needle parallel with facial alveolar plate.

If, however, the posterior superior alveolar nerve has not been reached and the molar teeth therefore are not anesthetized, a tuberosity injection should be made to complete the anesthesia of the outer nerve loop. It is quite obvious that if the posterior superior alveolar nerve was not reached by the solution, Meckel's ganglion will surely remain unanesthetized inasmuch as the ganglion is located posteriorly and internally to the nerve.

The central incisor tooth is partly innervated by the interlacing of the terminal branches of the opposite infraorbital nerve. When this tooth is to be operated on the anastomosis should be blocked by infiltrating the medial area with about ten drops of the anesthetic solution. The needle is directed slightly to the opposite side in order to better reach the anastomosing branches of that nerve.

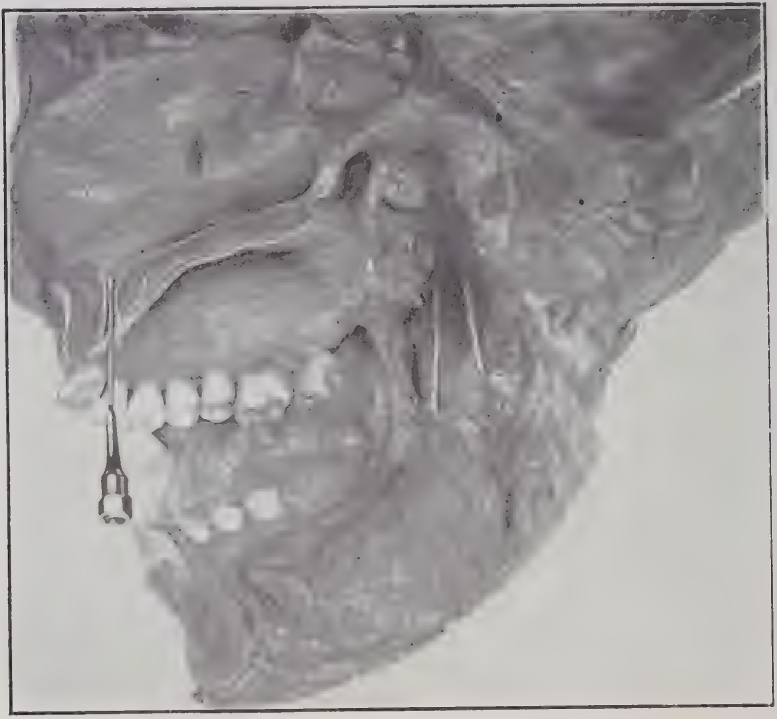


FIG 86. Needle in anterior palatine foramen shown on wet specimen.

Area Anesthetized by an Anterior Infraorbital Injection.

All the text books on anesthesia maintain that only the anterior superior alveolar nerve may be anesthetized by an infraorbital injection. Dr. A. E. Smith in his book, "Block Anesthesia and Allied Subjects," in describing the structures anesthetized by this injection states:

"In most cases only the lateral incisor is thoroughly anesthetized, but anesthesia of the central and cuspid teeth is only partial, because the interlacing and overlapping branches from the opposite side and from the middle superior dental on the same side are not blocked and must be anesthetized by other injections."

This does not coincide with the clinical experience of the writer. While this statement holds true as to the central incisor, the cuspid surely is always anesthetized by an infraorbital injection, unless the technique shall have been improperly carried out and the solution deposited into the canine fossa. The bicuspids also are almost invariably anesthetized by a correct injection. It may be safely stated that in at least three-fourths of the cases the upper three molars and their buccal alveolar plate are anesthetized and in about half of the cases, Meckel's ganglion is reached and the inner nerve loop thereby anesthetized.

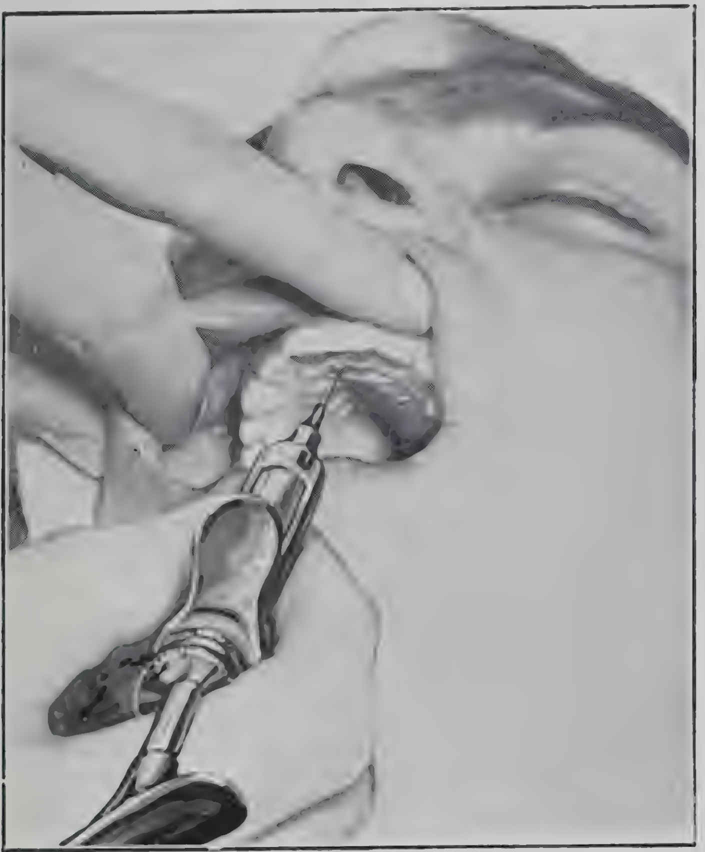


FIG. 87. Final position of needle in an anterior palatine injection shown on patient.

It would be hardly worth while to make an infraorbital injection to obtain anesthesia in the lateral incisor only, as this tooth could be anesthetized easily, in the absence of infection, by the ordinary infiltrative method.

The degree of success depends as much upon the proper point of injection as it does upon the infraorbital foramen itself. The foramen in some cases may be partially covered by a lamina of bone or may be so constricted as to obstruct the free passage of the anesthetizing solution into the infraorbital canal. In other cases this foramen is quite large and may be located easily and entered by the needle. In such cases the solution will be driven through the infraorbital canal; the bulb of the index finger presses tightly over the infraorbital foramen and prevents the solution from escaping and diffusing outside of the foramen. (Fig. 88.)

Induction Anesthesia.

The method of producing anesthesia in the bicuspids and molars by means of an anterior infraorbital injection could be termed "induction" instead of "conduction." In conduction anesthesia the nerve is blocked at the point where the solution is deposited. In an anterior infraorbital injection the solution is forced by pressure to travel through the infraorbital canal and by "induction" it reaches the anterior, then the middle and posterior superior alveolar nerves.

The writer has observed in a number of cases, in an anterior infraorbital injection, that the anesthesia in the upper bicuspids and molars will not be as profound as in the anterior teeth or as in a mandibular injection, and that it will be of an evanescent character. This must be due to the fact that the anesthetizing solution in these cases does not reach the middle and posterior superior alveolar nerves in sufficient quantity to completely anesthetize them.

Dangers from an Anterior Infraorbital Injection.

Many operators hesitate to make an anterior infraorbital injection for fear of some postinjection complication. To the writer's mind this injection is just as safe as any other in nerve blocking. The danger of injury to the infraorbital nerve or of entering into the infraorbital artery is practically eliminated, even though the needle should enter the infraorbital foramen. We must remember that these structures are enclosed in a common fibrous sheath, very tough and very slippery, which will recoil from the contact of the needle.

Veins to be Avoided.

There is the danger, however, of entering either the infraorbital or else the anterior facial vein and thus injecting the solution intravenously. A very

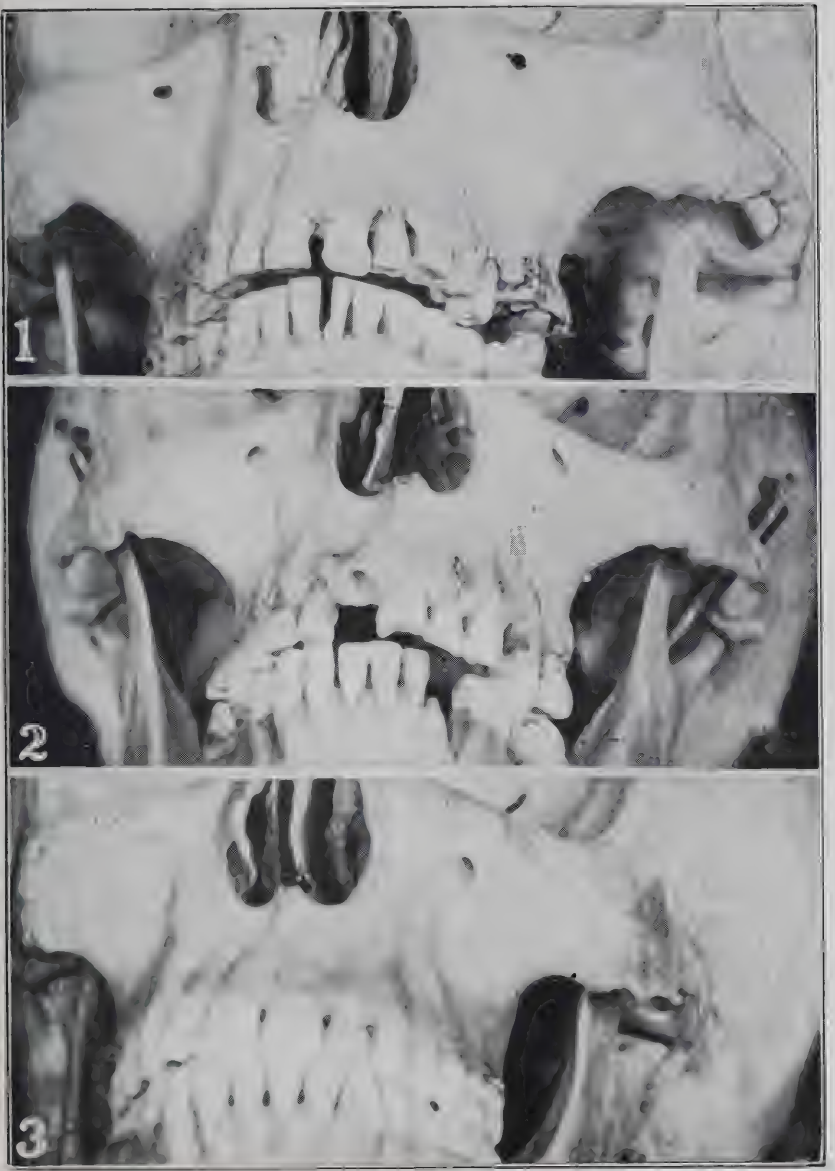


FIG. 88. Infraorbital foramina in different skulls. 1. Infraorbital foramina are large affording easy entrance for the needle and solution. 2. Infraorbital foramina fairly large. 3 Note partial closure of right infraorbital foramen. In such cases it would be very hard to obtain anesthesia of the bicuspid teeth with an anterior infraorbital injection.

simple method of determining whether the needle is in a vein or not is as follows: When the needle is in its final position and just before the expulsion of the anesthetic solution, the plunger is drawn back slightly. If the needle is in a vein the blood will rush into the barrel of the syringe. The position of the needle should be changed, but not withdrawn from the tissues, placing it at a different point, and the test is repeated. If the needle is not in a vein, by pulling the plunger slightly back, a vacuum will be formed in the barrel of the syringe. The solution is then slowly injected with the assurance that the blood stream is avoided.

Ecchymosis. Another disagreeable postinjection sequela, in an infraorbital injection, is ecchymosis or discoloration of the skin. This, to the mind of the writer, is due mainly to trauma, created by injecting the solution into muscle tissue. If the needle is kept too close to bone, the caninus muscle will be injected. If inserted and directed too far away from bone, the needle may enter the caput infraorbitale and the solution will be deposited therein. In either case the tissues are traumatized. More blood is rushed to the place in an effort to repair the injury. Blood stasis and venous exudation result and ecchymosis follows.

Discoloration may be due also to the entrance of the needle into a vein thus causing venous exudation.

The condition is very similar to the pathology of a "black eye" from a fistic encounter. The blow acts as a mechanical irritant, producing inflammation. Hyperemia follows. The terminal arterioles and veins in the affected area are gorged with the blood, causing the extension of their walls and paralysis of their muscle coat. At this stage the flow of blood is retarded, finally ending in partial stasis. The leucocytes migrate from the blood vessels, and at the same time exudation of the liquor sanguinis accompanied by coagulation of the fibrinous element takes place. This partial stasis is the cause of the discoloration. As the exudates are gradually absorbed and the blood current again resumes its normal flow, the skin is restored to its normal color.

Posterior Infraorbital Injection.

In a posterior infraorbital injection we endeavor to deposit the anesthetizing solution at the posterior termination of the infraorbital canal, or where the second division enters the infraorbital groove and becomes the infraorbital nerve. In this manner the solution blocks the nerve at a point before the three branches supplying the upper teeth are given off, producing anesthesia of the entire maxilla on the side of the injection.

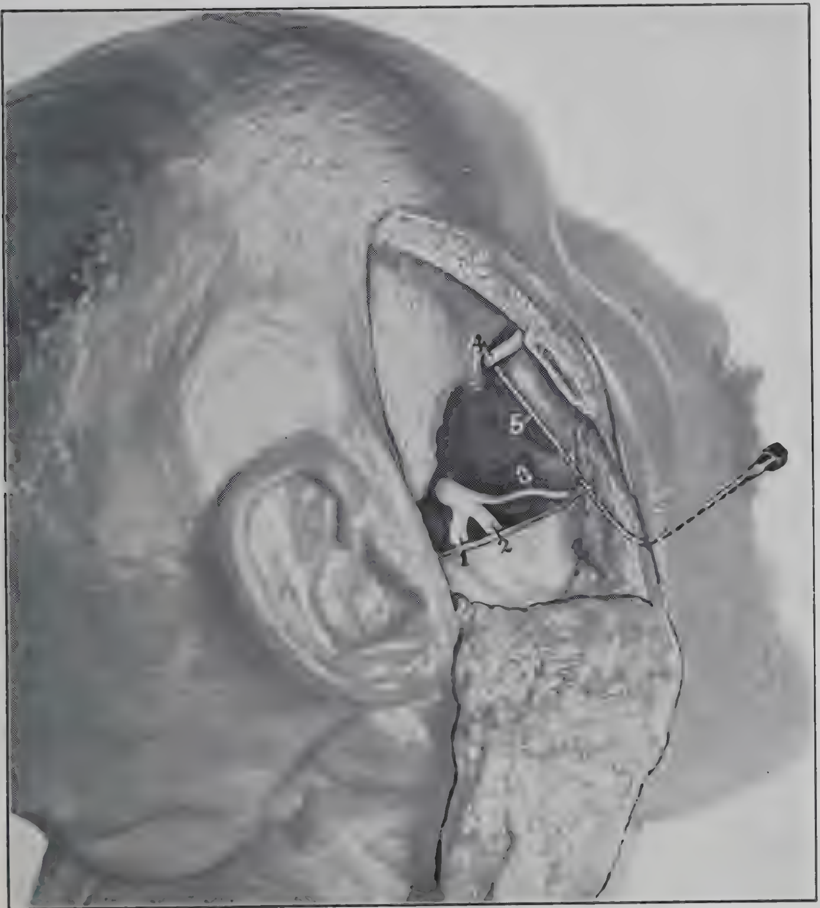


Fig. 89. Second division crossing the pterygopalatine fossa and entering the infraorbital groove, where it becomes the infraorbital nerve. 1. Inferior dental nerve. 2. Lingual nerve. 3. Long buccal nerve. 4. Second division. 5. Position of needle in a second division injection.

A number of men have advocated the blocking of the entire superior maxillary nerve. Dr. Matas of New Orleans was the first man to attempt to anesthetize this nerve at the foramen rotundum extraorally. This he accomplished by passing the needle beneath the inferior border of the zygoma and along the posterior surface of the superior maxilla. The second division can be reached and anesthetized also by the orbital route. The needle is passed along the outer wall of the orbit, through the sphenomaxillary fissure and into the pterygopalatine fossa where the solution is discharged. These extraoral injections will be considered later in a separate chapter dealing with that subject.

To Dr. A. E. Smith is due the credit of perfecting the technique and of being the first to anesthetize the second division intraorally.

Smith's Method.

Briefly, the technique of Dr. Smith's injection is as follows: A 40 mm. 22 gauge iridio-platinum needle with an extension hub is used. The patient's mouth is half open. Standing in front of the patient, the needle is inserted into the mucous membrane between the buccal mucous membrane above the third molar tooth and the inner side of the cheek. The needle is then advanced upward, inward and slightly backward to an approximate depth of 15 mm. or until the needle reaches the lateral surface of the tuberosity. The needle then is advanced in close contact with the periosteum covering the posterolateral surface of the tuberosity another 15 mm. 4 cc. of a 2 per cent procaine solution are then injected. The extension and hub should occupy a position midway between the upper and lower teeth, but should not be parallel to the occlusal plane of the upper teeth. If the extension hub is held parallel to the occlusal plane of upper teeth, the needle, when inserted, may strike the external pterygoid plate and thus be kept away from the second division. (Fig. 89.)

The writer has modified this technique somewhat.

As far back as 1917 he attempted to anesthetize the infraorbital nerve at the pterygopalatine fossa intraorally through the pterygopalatine canal. The injection was made by passing a 42 mm. needle into the posterior palatine foramen and advancing it along the pterygopalatine canal for a distance of about 25 mm. (1″) and discharging the solution in the pterygopalatine fossa. The needle will frequently strike the under surface of the greater wing of the sphenoid at the junction with the pterygoid process. This point is just below the foramen rotundum.

This method, however, is not successful and is fraught with danger. It is not successful because of the inaccessibility and the difficulty of passing through the pterygopalatine canal, as this canal is frequently constricted in its course and offers resistance to the passage of the needle. The danger arises from the fact that in this narrow space are located the three palatine nerves and ascending palatine artery together with the accompanying veins, offering an opportunity to the needle in its prolonged course to enter the artery and particularly the vein, or perhaps do some injury to the palatine nerves.

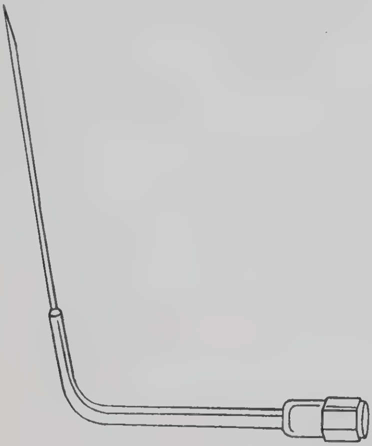


FIG. 90. Needle for posterior infraorbital injection.

The writer's next attempt was to reach the second division by passing a curved needle along the posterior surface of the superior maxillary bone in order to reach the infraorbital groove. This, also, was not very successful, as there was a tendency for the needle to be inserted too far posteriorly; thus the second division generally was missed. Anesthesia would be obtained in the molars and occasionally in the bicuspids. The curved needle was abandoned and a 42 mm. needle mounted upon a right angle attachment was employed. (Fig. 90.) This attachment enables the operator to keep the needle in close proximity to the posterior surface of the superior maxillary bone as it is advanced toward the pterygopalatine fossa.

The examination of the course of the second division will show us that this nerve after crossing the sphenomaxillary fossa, turns slightly externally to the infratemporal fossa to reach the infraorbital groove. (Fig. 89.) It will be observed that the easiest route by which to reach the infraorbital groove will be from a point on the zygomatic surface which will clear the malar process. This corresponds in the adult to a point on the reflection of the mucous membrane above and between the apices of the buccal roots of the second upper molar tooth. (Fig. 17.) The distance between the point of the insertion of the needle and the point where the infraorbital nerve enters the infraorbital groove, when measured in a number of skulls, varied from 25 mm. to 30 mm.

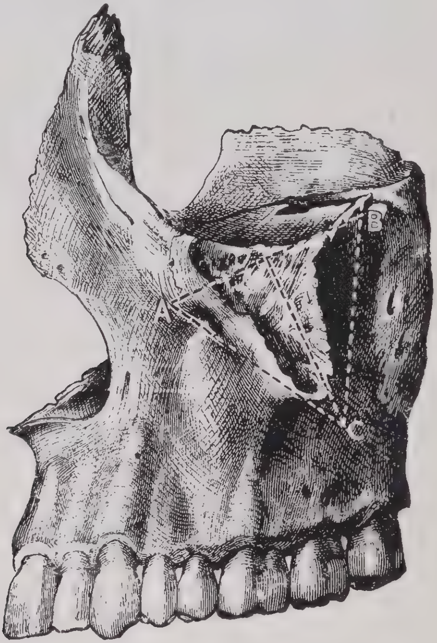


Fig. 91. A. Infraorbital foramen. B. Posterior termination of infraorbital canal. C. Point of needle insertion. The distance between A and C is equal to the distance between C and B.

Distance from Point of Insertion.

Another interesting point is this: If an imaginary line be drawn from the point clearing the malar process, or above the apices of the second molar tooth at right angles to the infraorbital canal, it will be found to bisect the canal, forming thereby two equilateral triangles whose hypotenuses will be equal. AB will be equal to BC. In other words the distance from the infraorbital foramen to the point of insertion of the needle B will be equal to the distance from the point of insertion B to the posterior termination of the infraorbital canal, where the solution is to be deposited. Then by measuring AB we can determine the distance the needle must travel in order to reach the infraorbital nerve. However, since the distance seldom exceeds 30 mm., the needle is inserted to that length with fair assurance that the desired area will be reached. (Fig. 91.)

Needle Used. For this injection a 42 mm. 21 gauge iridio-platinum needle, mounted on a right angle attachment, is used. The patient is placed in a comfortable reclining position, the operator standing in front and slightly to the side of the patient.

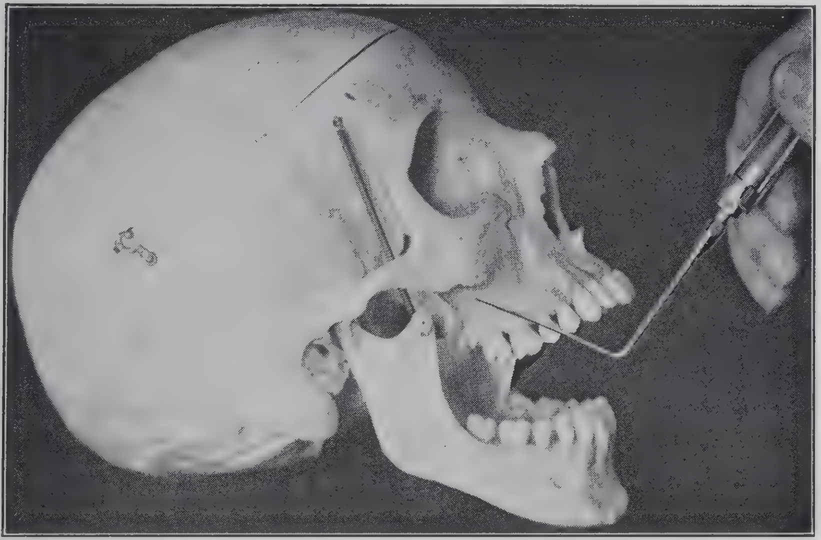


Fig. 92. Insertion of the needle in a posterior infraorbital injection on skull.

Technique. The malar process is palpated with the index finger in order to determine the point of insertion of the needle so as to clear the malar process. This point, as explained, generally corresponds to the apices of the second molar tooth in an adult. The cheek is pushed away with the index finger of the left hand and the reflection of the mucous membrane above the second molar tooth is painted with tincture of iodin. The syringe with the special needle is then picked up in a pen-like manner and the needle is inserted slightly away from bone in the reflection of the mucous membrane above the second molar tooth or at the point clearing the malar process. (Figs. 92 and 93.)

The needle is advanced superiorly and internally endeavoring, as much as possible, to be in contact with the zygomatic surface of the superior maxilla, until about 30 mm. (1¼″) of the needle has disappeared into the tissues. Between 3 and 4 cc. of a 2 per cent procaine solution are here slowly injected. As the needle is advanced in the tissues, the operator is enabled to move the extension hub downward in order to approximate the needle to the posterior surface of the superior maxilla. (Figs. 94, 95 and 96.) The insertion of the needle above the second molar instead of the wisdom tooth will be found not only easier but will enable the operator to keep in contact with the posterior surface of the maxilla with greater facility.

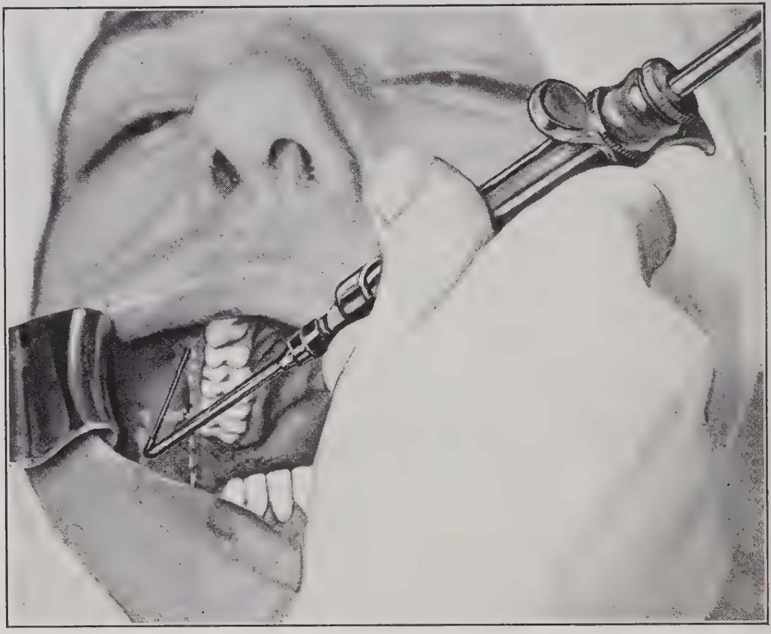


Fig. 93. Insertion of needle in a posterior infraorbital injection on patient. Note direction of needle internally at an angle of about 30° to a straight line drawn from the buccal surfaces of the upper to the buccal surfaces of the lower molar teeth.

Direction of Needle.

It is of great importance to remember that the needle should be directed at a distinct angle internally toward the pterygopalatine fossa. If a line be drawn buccally from the upper to the lower molar teeth, the needle should assume an angle of about 30° to this line. To make it still plainer, the needle (not the extension) should be at an angle of about 30° to the buccinator muscle or the cheek. This is necessary in order to reach the infraorbital groove and the infraorbital nerve. A mistake frequently made here is to direct the needle only superiorly and not internally. In such cases the temporal fossa will be entered, the solution will be deposited quite a distance away from the infraorbital nerve, and no anesthesia will be obtained.

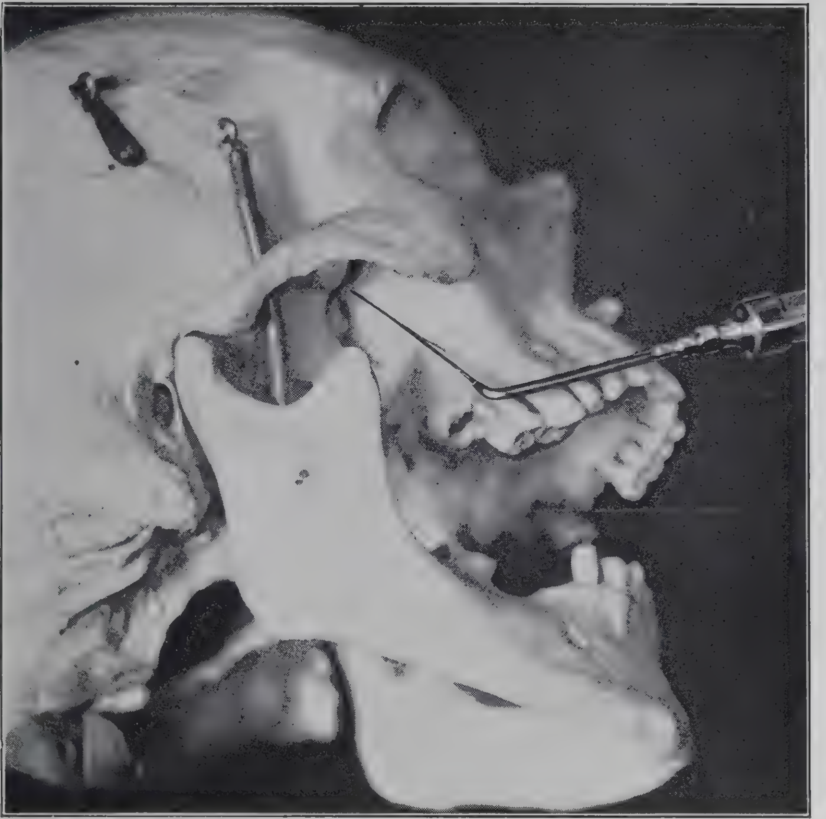


Fig. 94. Final position of needle in a posterior infraorbital injection on skull.

Landmarks. Unlike the mandibular or anterior infraorbital, we have no positive landmarks in this injection. Our landmark in an anterior infraorbital injection is the under surface of the infraorbital ridge. In a mandibular injection the posterior boundary of the sulcus serves as a landmark. In the posterior infraorbital injection the best we can do is simply to insert the needle to a certain length and in a certain direction and inject, hoping that we will be near enough to the infraorbital nerve to anesthetize it, or else that it will be finally reached by the diffusion of the injecting solution. For this reason the injection of a larger quantity of the anesthetizing solution is advisable. However, in this injection the needle will frequently encounter bony obstruction. If the needle has been properly directed, the under wing of the sphenoid or the sphenoidal spine may be encountered. Anesthesia in such cases will be obtained. Should the needle be directed too far posteriorly and not be kept in proximity to the posterior surface of the superior maxilla, the external surface of the external pterygoid plate may be encountered and the external pterygoid muscle infiltrated, with a possibility of invading the pterygoid plexus of veins and creating a hematoma.

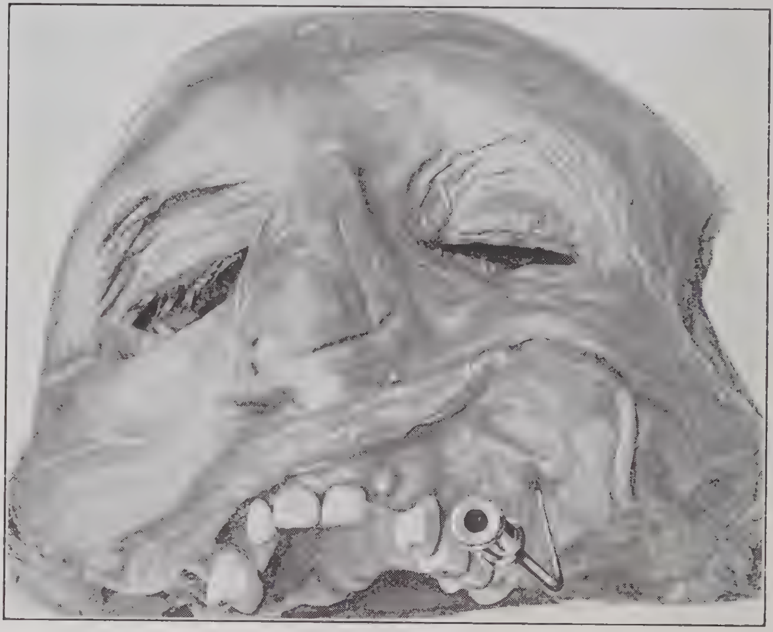


Fig. 95. Final position of needle in a posterior infraorbital injection on wet specimen as seen at the reflection of the mucous membrane.

Anesthesia of the molars and bicuspids is generally obtained by this injection. The anterior teeth will seldom be anesthetized due undoubtedly to the anastomosis from the opposite infraorbital nerve.

Safety. As to the safety of the posterior infraorbital injection, to the writer's mind, it is as safe as any other nerve blocking injection. The part of the infratemporal fossa through which the needle travels is devoid of important structures. There are no arteries nor veins of any importance in this region nor are there any muscles to be injected, when the proper course is pursued. The internal maxillary artery on its course to the pterygopalatine fossa is from 15 to 20 mm. away from the path of the needle. The space through which the needle travels is filled with adipose tissue. The dangers of the needle penetrating the sphenomaxillary fissure and entering the orbit, are to be discounted. The tendency of the needle is to pass posteriorly, particularly when inserted too high. In order to penetrate the sphenomaxillary fissure it would be necessary to force the right angle attachment way back into the oral cavity, which is an impossibility.

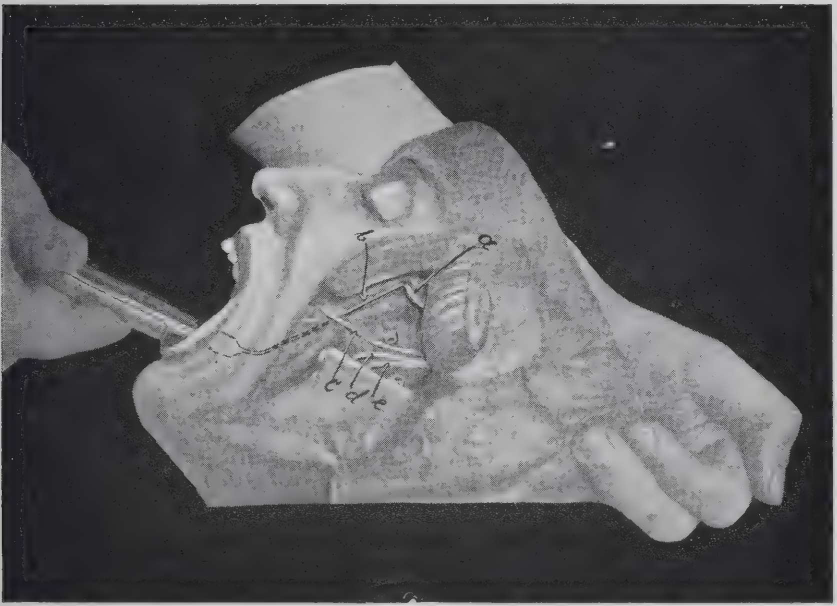


Fig. 96. Posterior infraorbital injection as seen from the infratemporal region. A. Infraorbital nerve entering infraorbital groove. B. Needle. C. Long buccal nerve. D. Lingual nerve. E. Inferior dental nerve.

The posterior infraorbital injection is not more difficult than any other nerve blocking injection. It may be a little more awkward to the beginner, but a little practice will finally enable the operator to make this injection with as much dexterity as any other. For the dental surgeon, however, in his daily routine, the field of application for this injection is not as wide as for the other injections. His work could be painlessly performed on the superior maxilla with greater ease and with more certain results by means of the other injections described, namely, the anterior infraorbital, tuberosity and anterior and posterior palatine.

But occasions do arise when the posterior infraorbital injection will be particularly applicable and useful. For instance, in operating upon the antrum of Highmore. The inner wall of the antrum is innervated by the nasopalatine nerve and other branches given off Meckel's ganglion.

In order to obtain complete anesthesia of the antrum, a posterior infraorbital injection should be made. Care should be taken, in such cases, to direct the needle internally at an angle of about 45° instead of 30°, so that the solution may reach Meckel's ganglion. The anterior infraorbital injection does not always reach Meckel's ganglion, while the anterior palatine injection will only anesthetize that portion of the nasopalatine nerve which emerges from the anterior palatine foramen and is distributed to the palatal alveolar plate of the central, lateral and canine teeth.

The posterior infraorbital injection is valuable to the dental surgeon in cases of removal of an impacted upper third molar tooth, particularly when the roots of this tooth are high up and above the posterior superior alveolar canals. In such cases the tuberosity injection will not always avail, as the anesthetizing solution will seldom reach that portion of the posterior superior alveolar nerve, which is above the posterior superior alveolar foramen. The posterior infraorbital injection, by anesthetizing the second division before it enters the infraorbital groove, will also automatically block the entire posterior superior alveolar nerve.

CHAPTER V.

PTERYGOMANDIBULAR ANESTHESIA.

Of all the nerve blocking injections, the mandibular ranks as the most important for the dental surgeon.

Every dental practitioner who has attempted to anesthetize a lower molar tooth with an infiltration injection, knows the great difficulties attending such procedure. The reason is quite obvious. A glance at a mandible will show us the great density and thickness of the alveolar plates in that region, so that diffusion of the anesthetic solution into the alveolus is very difficult and sometimes impossible. With one mandibular injection, however, it is possible to anesthetize not only the molars but nearly all the teeth to the median line on the side of the injection. (Fig. 97.)

The results obtained from this injection fully justify the expenditure of time and patience in mastering its proper technique. With but one injection at the sulcus mandibularis, the anesthetist is enabled to operate painlessly on that side of the mandible, having the added advantage of the patient's coöperation. Pulps may be extirpated, sensitive cavities prepared, roots extracted, abutments ground; in short, any dental operation may be painlessly performed.

The landmarks are positive, and therefore the percentage of success with this injection is greater than with any other. Yet no other nerve blocking injection is productive of so many postanesthetic complications as the mandibular. Not because these complications are unavoidable but because the injections are made without proper understanding of the surrounding anatomical structures, and the needle is allowed to enter areas which one should carefully avoid.

It is the writer's sincere hope that the student will acquaint himself fully with all the landmarks and important anatomical structures described in the preceding chapters before attempting to study the technique of the mandibular injection, as in its description frequent reference will necessarily be made to osteology, muscles, veins, arteries and nerves.

When one carefully examines the mandible, its structure, the attachment it affords to the various muscles, its innervation, its relation to the

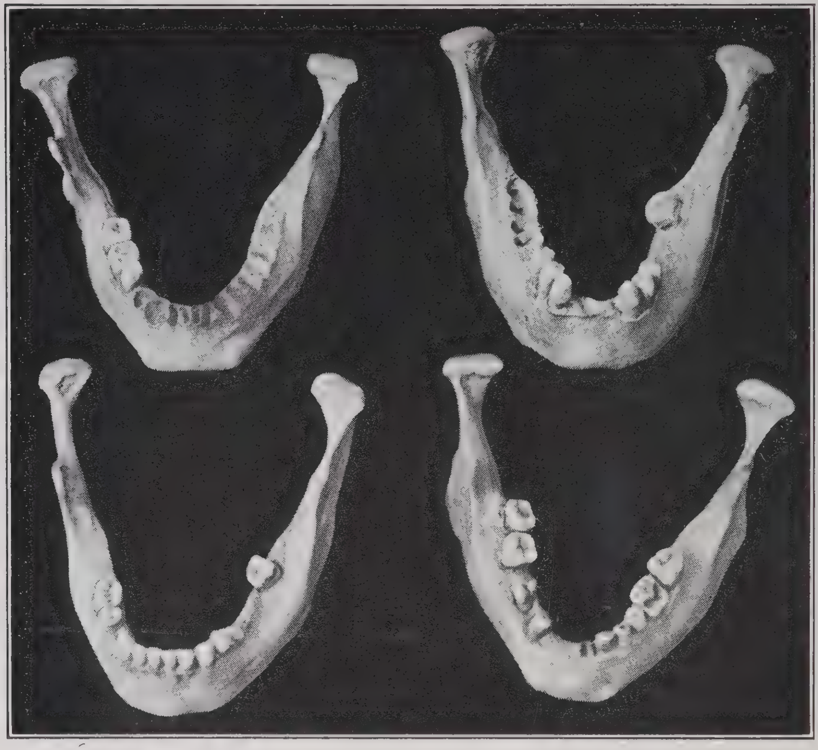


FIG. 97. Mandibles showing unusual thickness of the alveolar plates around the molar teeth. Absorption of the anesthetic solution is very difficult.

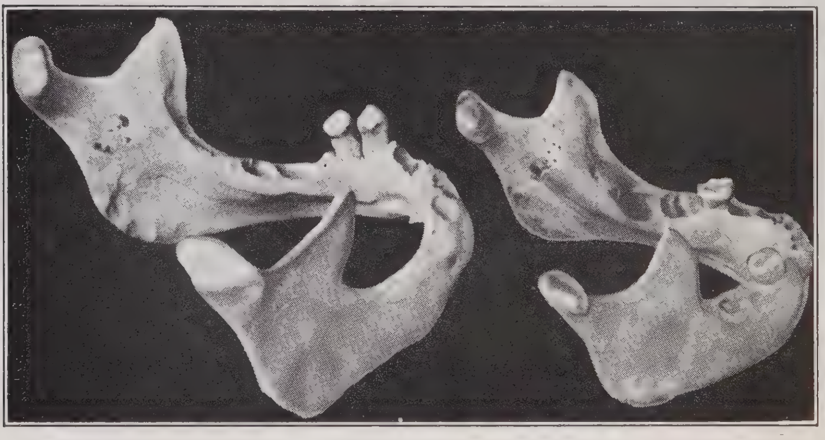


FIG. 98. Ascending rami showing accessory foramina to the large inferior dental foramen in the mandibular sulcus.

adjoining structures, one is impressed forcefully with the fact that everything appears to be arranged by nature as though with a view of enabling the dentist to make a mandibular injection with ease and little discomfort to the patient. Three of those vantage points should be particularly noted.

First. The depression in the center of the internal surface of the ascending ramus, the sulcus mandibularis, which is formed by the inferior dental foramen for the entrance of the inferior dental nerve. (Fig. 11.) Note the numerous small foramina around the main orifice. (Fig. 98.) Undoubtedly numerous branches from the main trunk of the nerve, together with accompanying blood vessels, pass through these foramina and ramify through the substance of the mandible, probably reaching even the alveoli. The anesthetic solution, when injected into the sulcus, although deposited away from the inferior dental nerve, promptly anesthetizes these filaments, giving rise perhaps to those feeble symptoms of anesthesia that manifest themselves at the beginning. Later, the solution, by diffusion, reaches the main trunk of the inferior dental nerve, thereby completing the anesthesia.

The posterior boundary of the sulcus turns inwardly. This is a distinct advantage, in that it enables the operator to strike it with the point of his needle, and so determine when the proper position has been reached. The lingula, at the anterior boundary of the sulcus, protects the inferior dental nerve and artery at their entrance into the foramen against possible contact with the advancing needle. (Fig. 11.)

Second. The pterygomandibular space. The coöperation of nature is remarkably illustrated by the formation of this triangular space. It is almost as though this space had been created just for the purpose of a mandibular injection. (See Figs. 20 and 25.) This space has been described in the chapter dealing with the muscles of mastication and the contents of the infratemporal fossa. It is well to remember that the outer boundary of the pterygomandibular space is the ascending ramus, the inner the internal pterygoid muscle. This space begins at the point of divergence of the ramus and the internal pterygoid muscle, which is inserted solidly into the lower portion of the inner surface of the ascending ramus as high as the lingula and the inferior dental foramen. From there on, the muscle runs away from bone on its way to the pterygoid fossa. The pterygomandibular space is filled with connective tissue, particularly of the areolar and adipose variety, which acts as an excellent sponge for the absorption and diffusion of the anesthetic solution. The needle, gliding in the pterygomandibular space, creates little or no pain because of the absence of terminal nerve endings in adipose tissue.

Third.

Nature obligingly leaves the area around the mandibular sulcus devoid of any muscle attachments. Fig. 13 shows the insertions of the muscles on the inner surface of the ascending ramus; the internal pterygoid into the lower portion of the mandible, the external pterygoid into the neck of the condyle and the temporal into the condyloid process. The mandibular sulcus, as well as the immediately surrounding area, is free from muscle fibers. Hence the solution, when deposited into the sulcus and the pterygomandibular space, will reach the inferior dental nerve. This provision of nature makes mandibular anesthesia possible, as otherwise the solution would be prevented by the muscle fibers from reaching the inferior dental nerve or absorption would be retarded should the solution be injected into the muscle tissue proper. (Figs. 13 and 99.)

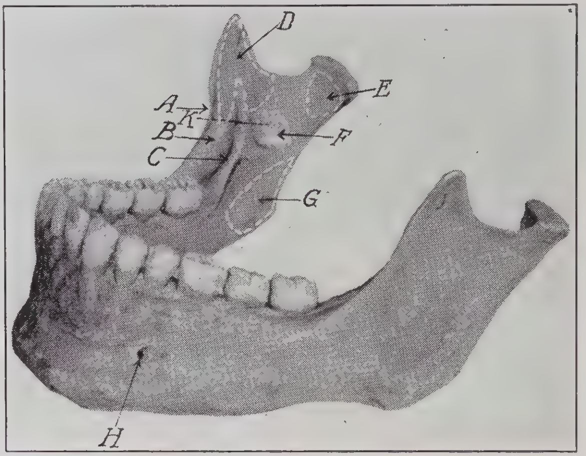


FIG. 99. A horizontal line drawn from the deepest point (K) of the depression on the anterior border of the ascending ramus will cross the mandibular sulcus (F) above the lingula. A. External oblique line. B. Postmolar fossa. C. Internal oblique line. D. Insertion of temporal muscle. E. Insertion of external pterygoid muscle. F. Mandibular sulcus. G. Insertion of internal pterygoid muscle. H. Mental foramen.

Proper Height for Needle Insertions.

It is the duty of the anesthetist to take full advantage of these important points, and, keeping these structures always in mind, he should direct his needle in such a manner that it reaches the mandibular sulcus, where the solution is deposited, resulting in quick and profound anesthesia.

But how can this be accomplished simply and easily? Unfortunately, the mandibular sulcus cannot be palpated, as it is far back in the infratemporal fossa. In this respect nature fails to coöperate with us. However, we can palpate other easily accessible structures from which our needle can be properly directed. These structures are the external and internal oblique lines and the postmolar fossa, previously described in conjunction with the mandible. (Figs. 9, 10 and 11.) It will be remembered that the deepest point of the depression on the external oblique line is on a line just above the lingula crossing the mandibular sulcus. (Fig. 99.) This line, in cases where the molar teeth are in normal position and occlusion, is 10 mm. (about ½ inch) above the occlusal plane of the molar and bicuspid teeth. It is evident, therefore, that should the needle follow this horizontal plane it will be at the proper height to reach the mandibular sulcus above the lingula.

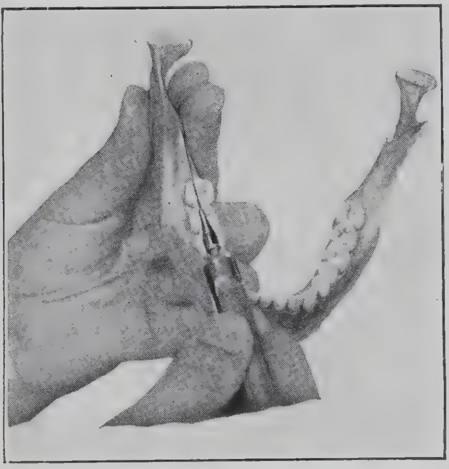


Fig. 100. The two fingers indicate the position of the internal pterygoid muscle. The needle must be inserted in such a manner that it will not penetrate the muscle on its course to the mandibular sulcus.

Muscle Must be Avoided.

The internal pterygoid muscle must be carefully avoided in this injection just as we avoid the external pterygoid muscle in a tuberosity, and the caninus muscle in the anterior infraorbital injection. This muscle has been sufficiently described in the previous chapters, so that the student can clearly visualize its actual position and direction, its origin and insertion. (Figs. 13, 19, 20, 24 and 25.) Its relation to the ascending ramus can be forcefully compared to the relation of the two fingers to the ascending ramus of the mandible as shown in the illustration. (Fig. 100.)

Fully realizing the importance of avoiding this muscle and directing our needle in the pterygomandibular space, it is quite evident that the needle must be inserted in such a manner, externo-medially and superio-inferiorly, that the internal pterygoid muscle will not be encountered. If the needle should be inserted laterally to the internal oblique line and too far toward the median line, the internal pterygoid muscle will be entered. Laterally is a relative term as applied to the insertion of the needle. It may be inserted just alongside the internal oblique line or the needle may be inserted half an inch away from it medially and the muscle will be entered. But if our needle strikes a point on the bone which corresponds to the internal oblique line or the postmolar fossa, we are assured that we will not enter the fingers (Fig. 100), or the internal pterygoid muscle of the patient.

So much for the externo-medial insertion. We must remember, however; that besides striking bone, the needle must also be entered at a proper height above the occlusal surfaces of the teeth; otherwise, when inserted too low and released from bone, the needle will enter the fingers (Fig. 100), which correspond to the area of the internal pterygoid muscle. Thus the precaution taken to avoid muscle medially will be of no avail. This proper height has been determined to be about 1 cm. above the occlusal plane of the lower teeth in a normal case or the deepest point of the depression on the anterior border of the ascending ramus.

Structures in an Open Mouth.

Before describing the technique in detail, let us again examine a wide open mouth and clearly establish the various structures which we see and are to palpate. It will not suffice just to call them vaguely tissues, mucous membrane, etc., but a clear understanding of these parts is imperative and will enable the operator to proceed with the injection with firmness and confidence. First, the mucous fold is clearly discernible. This is a muscle band uniting the last upper molar tooth with the last lower molar tooth. In reality it is a ligament, the pterygomandibular ligament, obtaining its name from the fact that it unites the pterygoid plate (its hamular process) with the internal oblique line of the mandible. This ligament separates the buccinator muscle from the superior constrictor of the pharynx. (Figs. 8 and 101.) The anesthetist is tempted to insert his needle into this molar fold, laboring under the delusion that because of its position just posterior to the molar teeth, it must be alongside the ascending ramus. As a matter of fact, it is quite some distance away from the ramus. This can easily be seen on the dissected side in the illustration. (Fig. 8.) The needle, if inserted into the molar fold, will pass into the internal pterygoid muscle which at this height lies externally to the superior constrictor of the pharynx and posteriorly to the fold. The molar fold, if anything, should serve the operator as a danger signal and should be carefully avoided. The needle is inserted externally to the molar fold, striking bone. This point of insertion may be from a quarter to half an inch away from the molar fold.

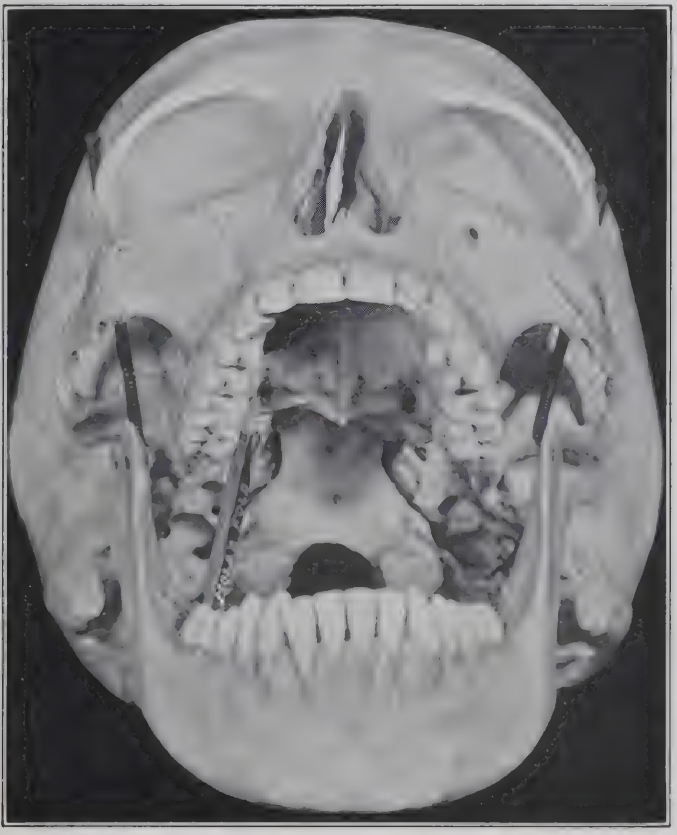


FIG. 101. Schematic arrangements showing the position of the molar fold on dry skull. This pterygomandibular ligament arises from the hamular process of the pterygoid process above and is inserted into the internal oblique line below. Note the distance the fold is from the ramus.

Internally and posteriorly to this fold we have the anterior pillars of the fauces. Still further posteriorly are located the tonsils and the posterior pillars. Externally to the molar fold one may feel with his finger the anterior border of the ramus or the external oblique line, which is superimposed by a muscle band, the anterior border of the masseter muscle. The bulb of the finger when placed on the inner surface of the ramus and just externally to the last molar tooth will fall into a depression, the postmolar fossa, which, as we already know, is bounded externally by the external oblique line and internally by the internal oblique line. The internal line is not easily found, as it very often blends with the inner surface of the ramus. For this reason the writer has practically eliminated the internal oblique line, as a landmark, in mandibular anesthesia and is guided entirely by the external oblique line, which can be easily found and palpated. In inserting the needle and striking bone either the internal oblique line or else the postmolar fossa is encountered. The faintly discernible internal oblique line can always be found by directing our needle on a line with the buccal surfaces of the bicuspids and molar teeth. (Fig. 12.)

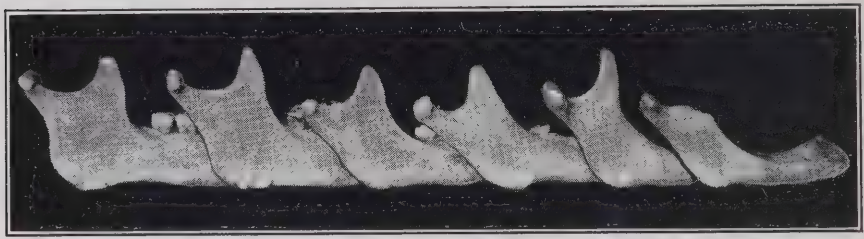


FIG. 102. Photograph showing the various widths of the ascending rami.

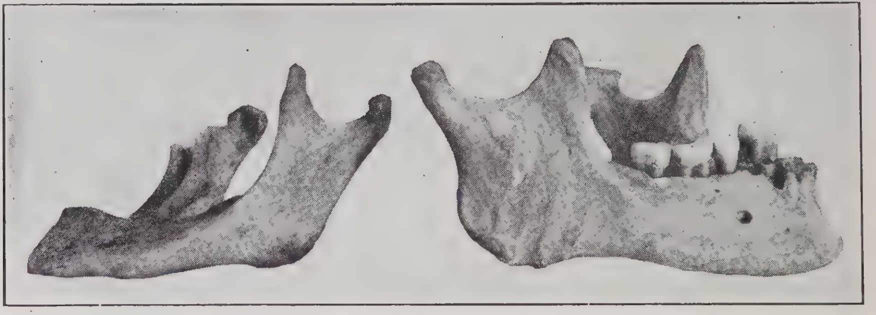


FIG. 103. One ascending ramus is twice as wide as the other.

With these general remarks and a clear understanding of the structures of an open mouth we may proceed with the description of the technique for a mandibular injection. Measurements and angles must be eliminated entirely when making a mandibular injection. Mandibles vary just as much as individuals. They vary in size, in the width and height of their ascending rami and in the various degrees of divergence of the rami from the body of the mandible. Therefore, the presumption that by inserting the needle to a certain length and directing the syringe in a certain position or angle the desired results may be obtained, is erroneous.

A number of text books advocate a 2 cm. insertion of the needle in a mandibular injection. Fig. 102 shows various widths of the rami, and, although one-inch insertion may bring the needle in proper position in some cases, yet in a majority of cases the needle may be inserted too far or may not reach the desired point. Note particularly Fig. 103, showing one ascending ramus twice as wide as the other. In one case the needle would pass the posterior border of the ascending ramus, into the parotid gland, and in the other case it would fail to reach the mandibular sulcus. Therefore, we should be guided altogether by the feel of the needle and not by the length of its insertion. By that we mean that when the needle is in contact with the posterior boundary of the mandibular sulcus, it is in the proper position.

Pterygomandibular Injection.

Technique for Mandibular Injection.

Let us suppose that we are to make a mandibular injection on the right side. The writer employs for this injection a 42 mm. (1⅝″) 21 gauge needle in steel or iridio-platinum, soldered to the hub. It is taken for granted that the solution has been properly prepared and that the needle has been properly sterilized. The operator stands in front of the patient and a little to the left. Holding the syringe in the right hand in a pencil-like manner, we palpate the landmarks with the index finger of the left hand. The finger is placed in the patient's mouth between the buccal surfaces of the lower teeth and the cheek and pushed gently backward until the anterior border of the ascending ramus is encountered. The muscle band representing the anterior border of the masseter muscle is recognized, care being taken not to confuse it with the hard long ridge of the external oblique line nor with the anterior border of the ramus. The bulb of the index finger is passed along the external oblique line until its depression is located. (Figs. 104-1 and 105.) With the bulb in the depression, the palm of the palpating finger is turned externally, the radial side of the finger being parallel with the occlusal surfaces of the lower molars and bicuspids, but not resting against those teeth. (Figs. 104-2 and 106.) Emphasis is particularly laid on the word "parallel" because so many men, after locating the de-

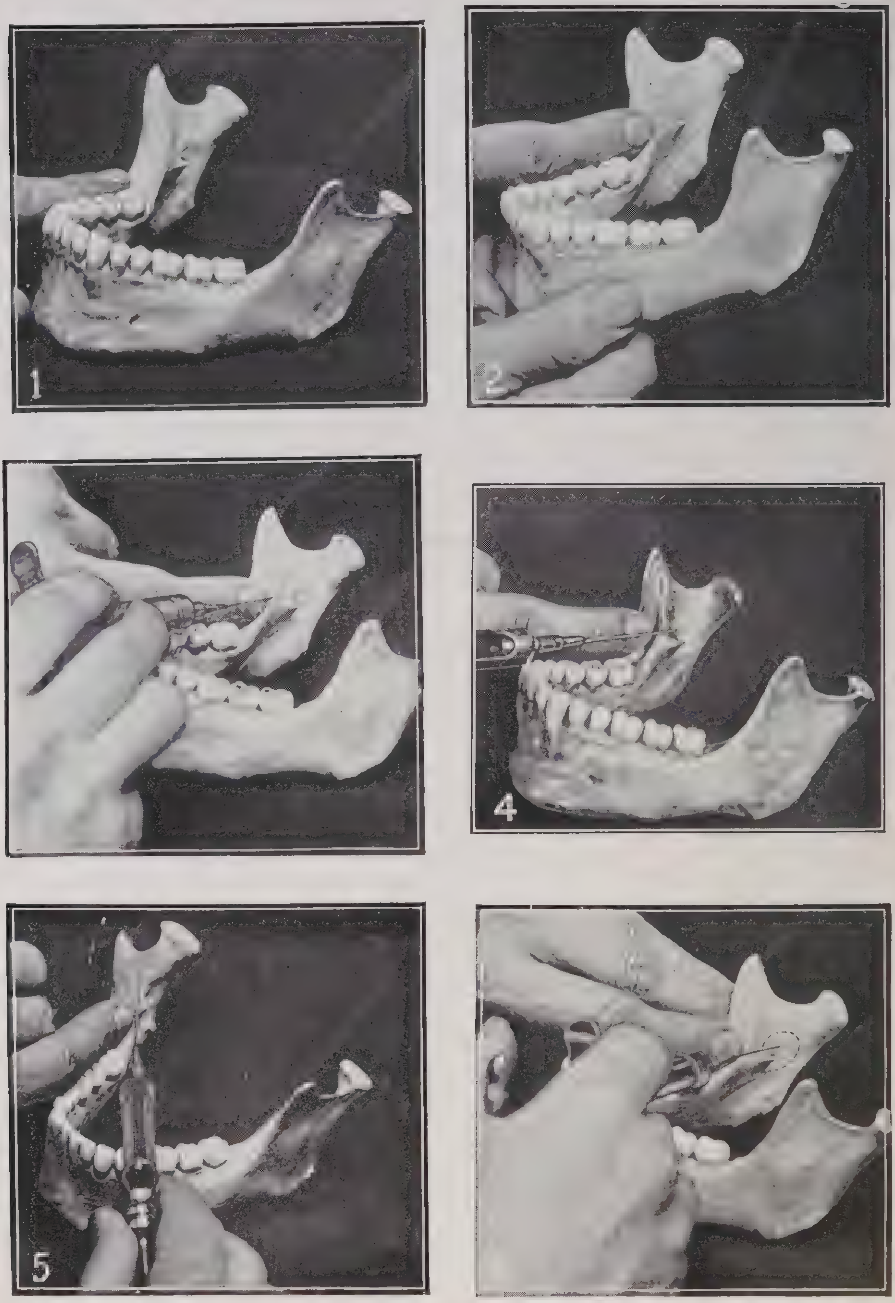


FIG. 104. Pterygomandibular injection shown on the mandible. 1. Palpating external oblique line (anterior border of ramus). 2. Bulb of index finger in depression of anterior border. 3. Insertion of needle. 4. Injection for lingual nerve. 5. Moving the syringe to the opposite side of the jaw. 6. Injection into the mandibular sulcus.

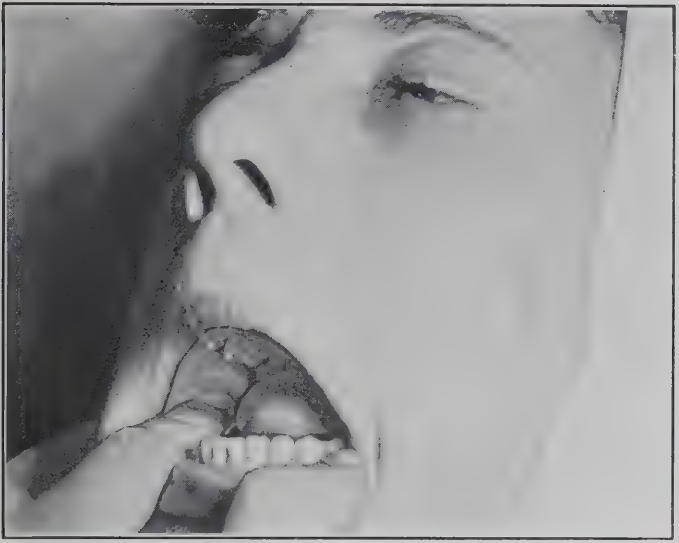


Fig. 105. Palpating external oblique line on patient.

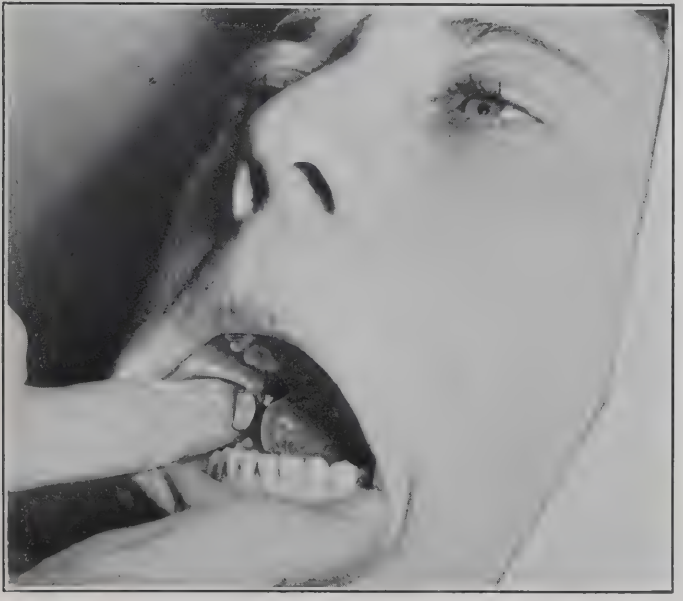


Fig. 106. Position of index finger for a mandibular injection. Bulb of finger is in depression of anterior border.

pression on the anterior border and placing the bulb of the index finger therein, will direct the finger in a distinctly downward direction with the result that when the center of the finger-nail is taken as a guide, the needle will be inserted too low. (Fig. 107.) By resting the finger on the occlusal plane the anesthetist's view of his field of operation is unnecessarily obstructed. In cases where the lower molars and bicuspids are in normal position and occlusion, the radial side of the index finger may be placed on a line parallel with the occlusal plane of those teeth, and the bulb of the finger resting upon the external oblique line may be used as a guide as to the proper height for the insertion of the needle. The depression in the anterior border of the ramus, in such cases, may be disregarded or used only as an additional landmark. The bulb of the index finger is placed on the external oblique line and not in the postmolar fossa nor on the internal oblique line. The mistake should not be made of placing the finger too far medially, thus covering the internal oblique line. This would prevent us from striking bone with

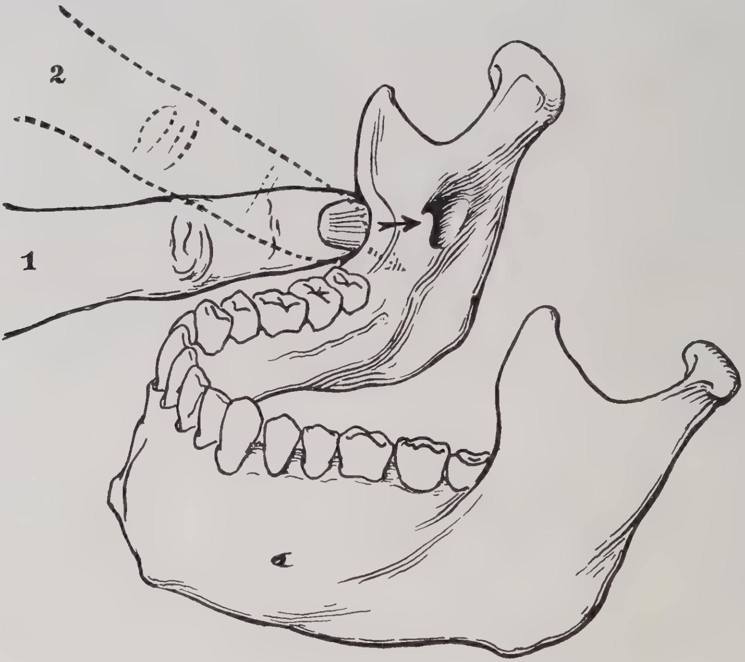


Fig. 107. Correct and incorrect position of finger for a mandibular injection. 1. Correct position. Finger parallel to the occlusal surfaces of the lower teeth, but not resting upon these teeth. 2. Incorrect position. Finger not parallel to the occlusal plane of the teeth. Needle directed from center of finger-nail will enter insertion of internal pterygoid muscle.

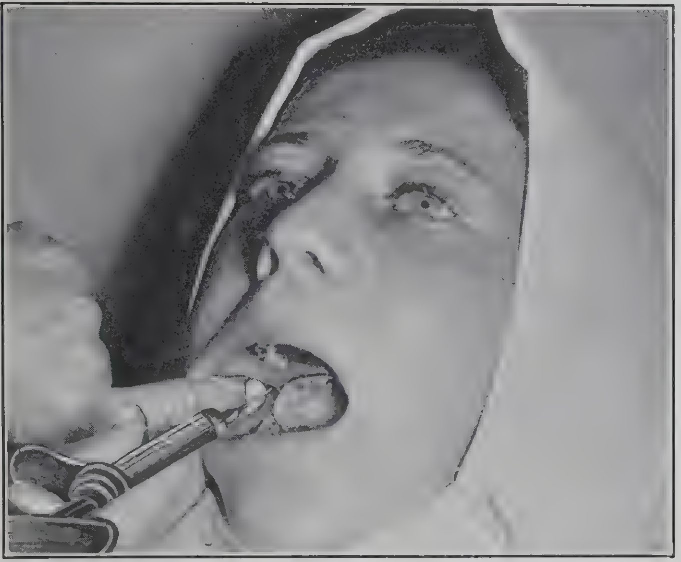


FIG. 108. Insertion of needle in a mandibular injection on patient.

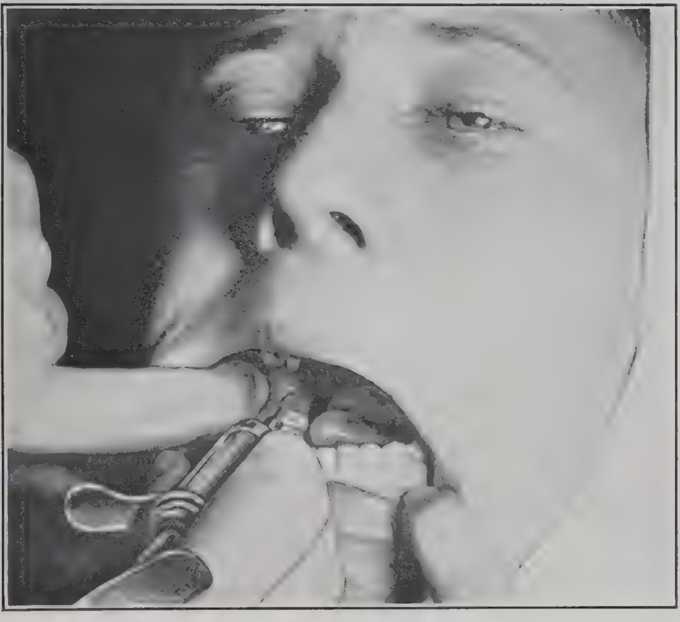


FIG. 109. Position for injection for lingual nerve.

the needle. Two things cannot occupy the same place at the same time.

The bulb of the finger is slightly retracted and the mucosa painted with tincture of iodin. The syringe, with an attached sterile needle, is picked up in a pencil-like manner and the needle inserted at the height of the center of the finger-nail, striking bone. Either the internal oblique line or the postmolar fossa may be encountered. (Figs. 104-3 and 108.) The syringe is held parallel to the teeth on the side of the injection. Some operators prefer inserting their needle from the opposite side. The writer's objection to this procedure is that in so doing, the operator may engage some of the fibers of the internal pterygoid muscle, and when bringing the syringe parallel to the side of the injection, some of the fibers of the internal pterygoid muscle may be engaged and unnecessarily traumatized. By inserting the needle parallel to the teeth on the side of the injection, only the mucous membrane covering the internal

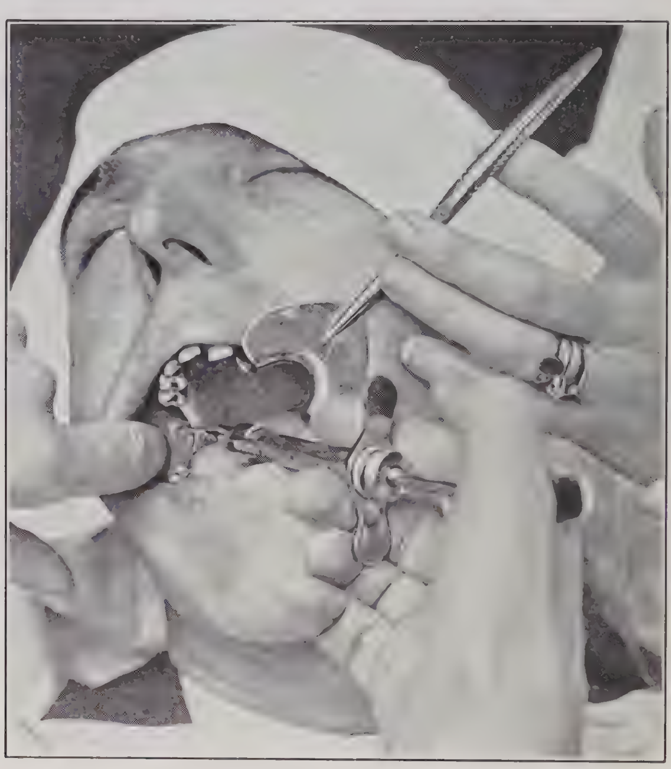


Fig. 110. Final position of needle in a mandibular injection. Solution being deposited in the mandibular sulcus.

oblique line and a few fibers of the buccinator muscle are penetrated, giving the patient very little, if any, pain. If the needle has been correctly inserted and bone encountered, the syringe and needle will be on a line with the buccal surface of the molars and bicuspids, for it will be remembered that the internal oblique line will be found on that plane.

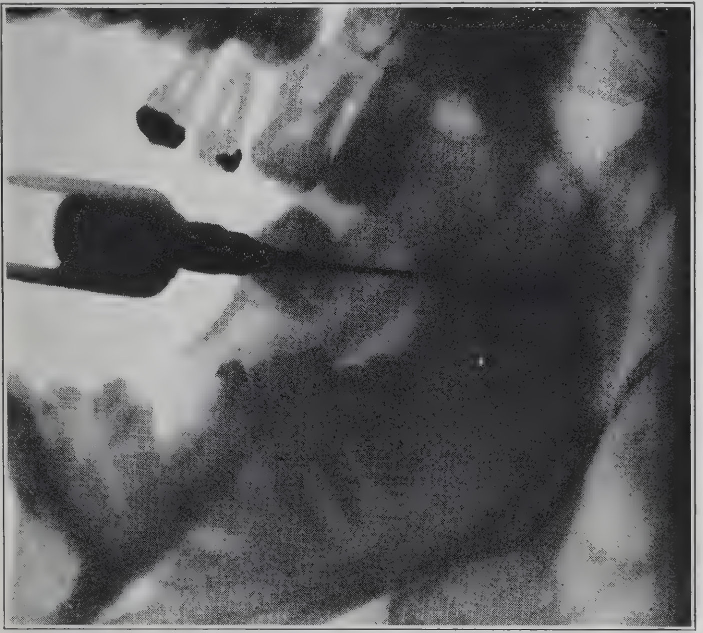


FIG. 111. Radiograph of patient showing needle in mandibular sulcus in a mandibular injection.

The needle will be about one centimeter (a little less than half an inch) above the occlusal plane of the teeth in a normal case.

The needle strikes bone for but a fraction of a second. This is only to assure ourselves that we are not entering too far toward the median line, in this manner engaging the internal pterygoid muscle. By maintaining the proper plane, namely the center of the finger-nail as it rests in the depression on the anterior border of the ramus, we are reasonably certain that the insertion of the internal pterygoid muscle will be cleared. In other words, we are beginning correctly, which is so essential to the successful termination of any undertaking.

Lingual Anesthesia.

The needle is now disengaged from the periosteum, but not withdrawn, and is advanced about 6 mm. (¼″), clearing the internal oblique line, yet holding the needle in lateral contact with the internal oblique line.

(Figs. 104-4 and 109.) This is very important. The writer has seen many operators, who, after striking the internal oblique line, will carry the needle quite a distance away from it, enter the internal pterygoid muscle and in this manner entirely destroy the advantages gained by the precautions taken at the initial puncture. It is important to release the needle from the periosteum; otherwise it will be held tightly against the internal oblique line, thus interfering with the free movements of the syringe during the injection and sometimes causing the needle to break. Occasionally considerable resistance to the penetration of the needle may be experienced. This is due to the temporal tendon, which in many cases may be inserted as low down as the lower wisdom tooth. When these cases are met, sufficient force should be used to penetrate the tendon and to proceed with the injection. The needle is now in the pterygomandibular space between the lingual nerve and the inner surface of the ascending ramus. About 8 or 10 minims of the solution are injected to anesthetize the lingual nerve. This will anes-

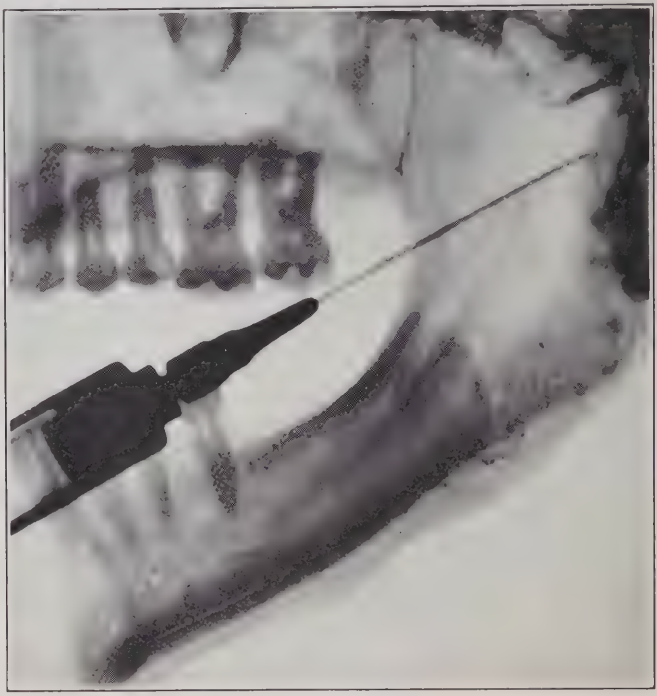


FIG. 112. Radiograph of wet specimen showing position of needle in a mandibular injection.

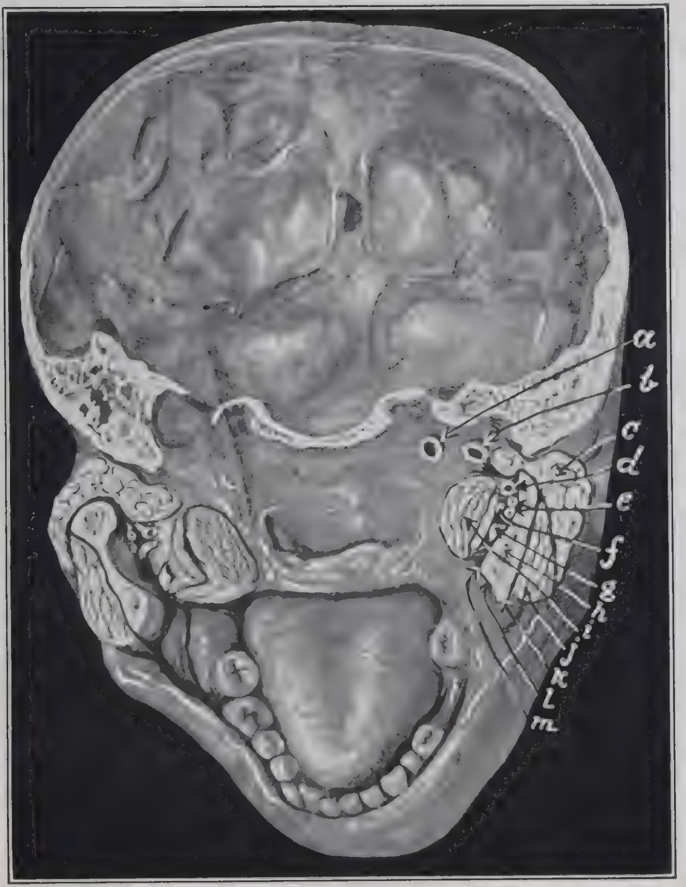
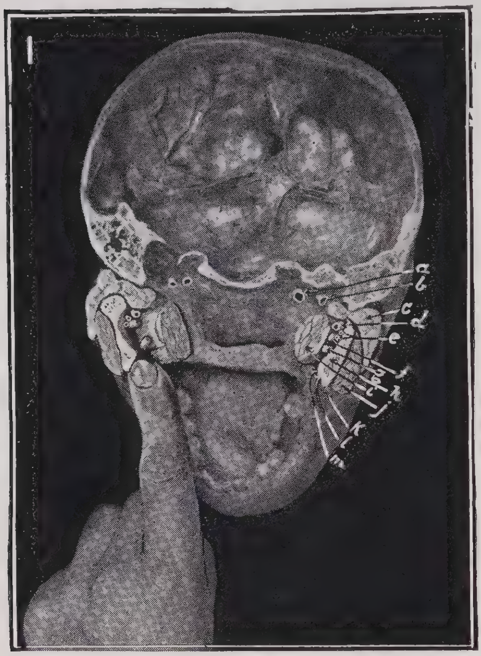


FIG. 113. Horizontal section of wet specimen about 1 cm. above the occlusal plane of the lower teeth. A. Internal carotid artery. B. Internal jugular vein. C. Parotid gland. D. Internal maxillary artery. E. Inferior dental artery. F. Inferior dental nerve. G. Lingual nerve. H. Ascending ramus. I. Internal pterygoid muscle. J. Masseter muscle. K. External oblique line. L. Postmolar fossa. M. Internal oblique line.

thetize the lingual mucous membrane of the lower teeth. Quite frequently the long buccal nerve will be anesthetized by this injection also.

Inferior Dental Anesthesia.

The inferior dental nerve remains to be anesthetized. It must be remembered that the ascending ramus diverges externally from the body of the mandible. In order to avoid entering the internal pterygoid muscle and still keep the needle in the pterygomandibular space, the syringe at this point is swung to the opposite side, advancing the needle posteriorly and externally, endeavoring to keep the needle in close proximity to bone until the point of the needle gently encounters the posterior wall of the sulcus mandibularis. (Figs. 104-6, 110, 111 and 112.)



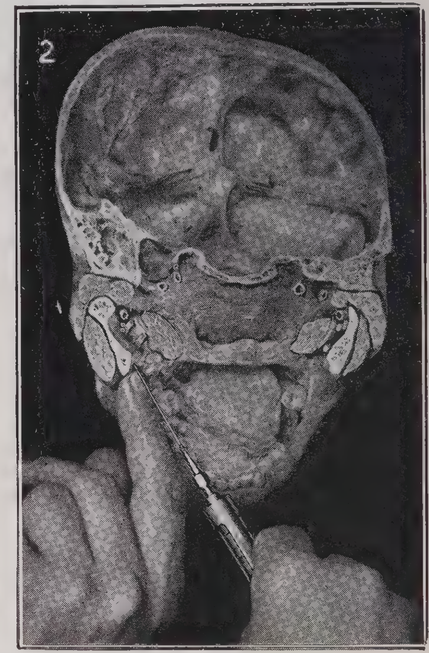
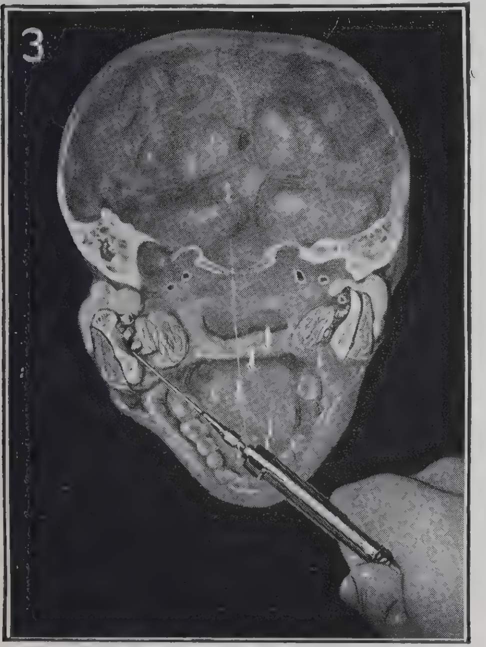


FIG. 114. 1. Palpating external oblique line on horizontal section.
FIG. 115. 2. Insertion of needle in a mandibular injection as shown on horizontal section

The exact position of the syringe on the opposite side is of secondary consideration, our aim being primarily to be in contact with the ascending ramus, so as to enter the mandibular sulcus and encounter its posterior wall. Examining the topographical anatomy of the ascending ramus, we cannot fail to note that if the needle is progressed above the lingula, in constant contact with bone, it must of necessity finally stop at the posterior boundary of the sulcus. When the needle is in contact with bone at this point, the remaining anesthetic solution of the 2 cc. syringeful is slowly injected. Care should be exercised not to strike bone too forcefully and repeatedly, as this would tend to produce periosteal inflammation and after pain.



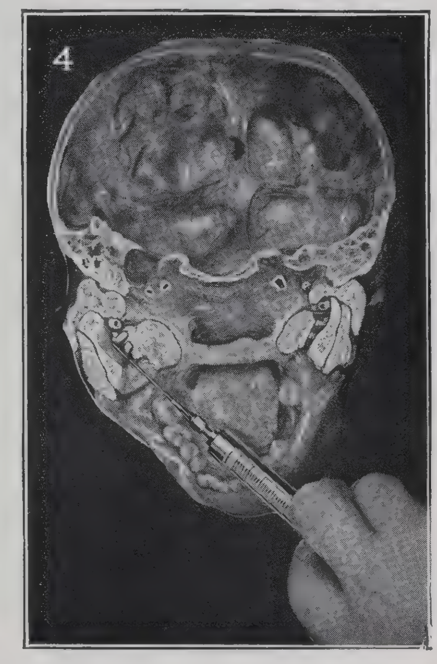


Fig. 116. 3. Injecting for the lingual nerve shown on horizontal section.
Fig. 117. 4. Injecting for the inferior dental nerve shown on horizontal section.

Injection Shown on Wet Specimen.

So far, the mandibular injection has been demonstrated on the patient and the mandible. Let us see how the same technique works on the wet specimen. Fig. 113 represents a wet specimen sectioned horizontally about an inch above the occlusal plane of the lower teeth or a little above the plane of the injection. Suppose that a mandibular injection is to be made. For convenience of injection and in order that we may follow the path of the needle, the upper portion of the section is removed. Here we see all the structures in proximity to the ascending ramus. Externally to the section of the ramus is the masseter muscle; internally the internal pterygoid muscle forming with the mandible the pterygoman-

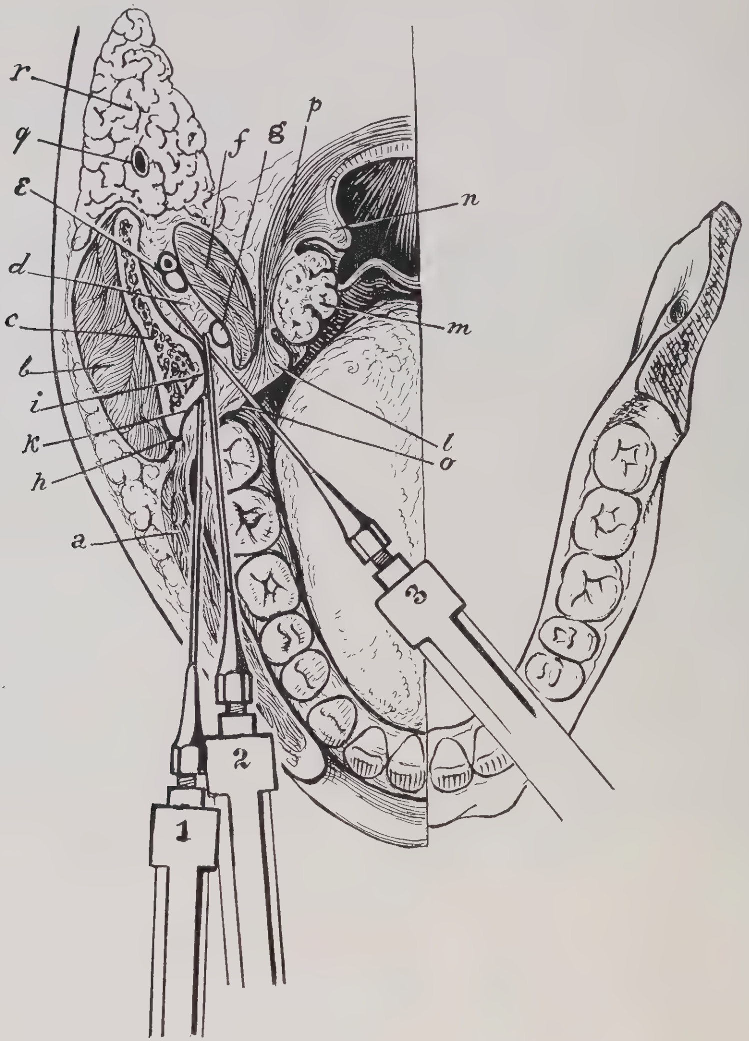


Fig. 118. The three positions of needle in a correct mandibular injection. 1. Insertion of needle striking bone. 2. Injection for lingual nerve. Needle in lateral contact with the internal oblique line. 3. Injection for inferior dental nerve. Needle striking posterior boundary of mandibular sulcus. A. Buccinator muscle. B. Masseter muscle. C. Ascending ramus. D. Pterygomandibular space. E. Inferior dental artery and nerve. F. Internal pterygoid muscle. G. Lingual nerve. H. External oblique line. I. Internal oblique line. K. Postmolar fossa. L. Anterior pillar of the fauces. M. Tonsils. N. Posterior pillar of the fauces. O. Molar fold. P. Superior constrictor of the pharynx. Q. Posterior facial vein. R. Parotid gland.

dibular space wherein the lingual nerve, the inferior dental nerve, artery and veins are located. Carrying out the technique described, the external oblique line is palpated and its depression located wherein the bulb of the index finger is placed. (Fig. 114.) Next the radial side of the finger is placed parallel but external to the occlusal plane and the needle is

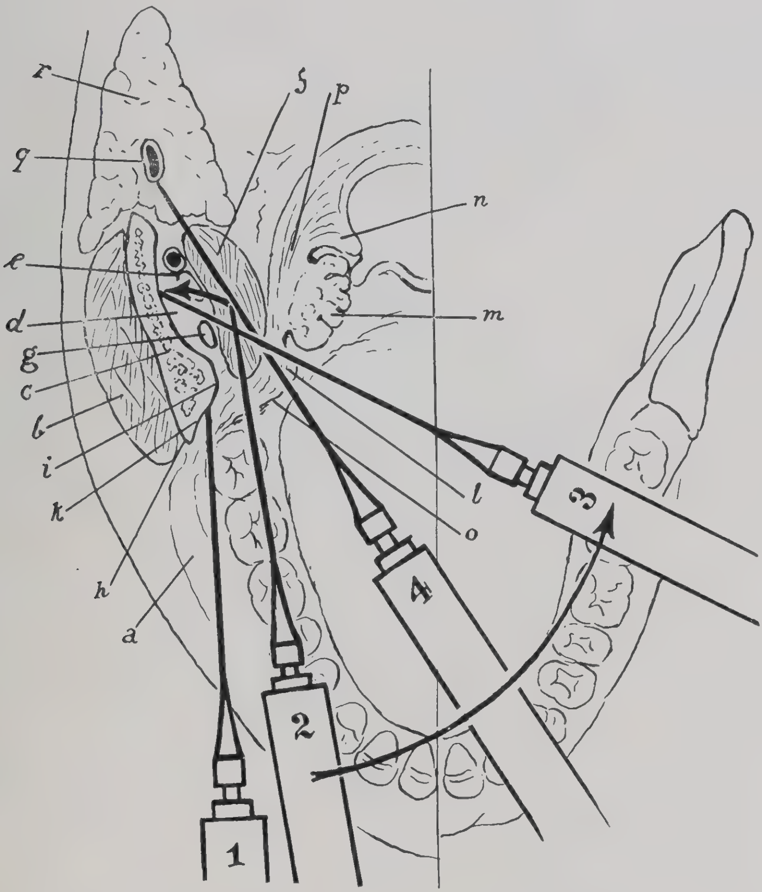


FIG. 119. Correct and incorrect insertion of needle in a mandibular injection. Incorrect positions of needle in a mandibular injection. 1. Correct insertion of needle. 2. Incorrect insertion of needle; the internal pterygoid muscle is entered. 3. If needle should be directed toward bone after an incorrect injection, it will again pass through the internal pterygoid muscle. 4. Needle incorrectly inserted may be directed too far posteriorly into the parotid gland and the posterior facial vein may be entered. For the structures designated by letters see legend of Fig. 118.

inserted at the height of the center of the finger-nail, striking bone. (Fig. 115.) The needle is released from the periosteum, inserted about a quarter of an inch, keeping the needle in lateral contact with the internal oblique line and a few drops are injected for the lingual nerve. (Fig. 116.) The syringe is now carried toward the opposite side while proceeding with the insertion. The needle is gliding in the pterygomandibular space, keeping in contact with bone until the mandibular sulcus is encountered, where the remaining solution is injected. (Fig. 117.) The needle is between the inferior dental nerve and bone.

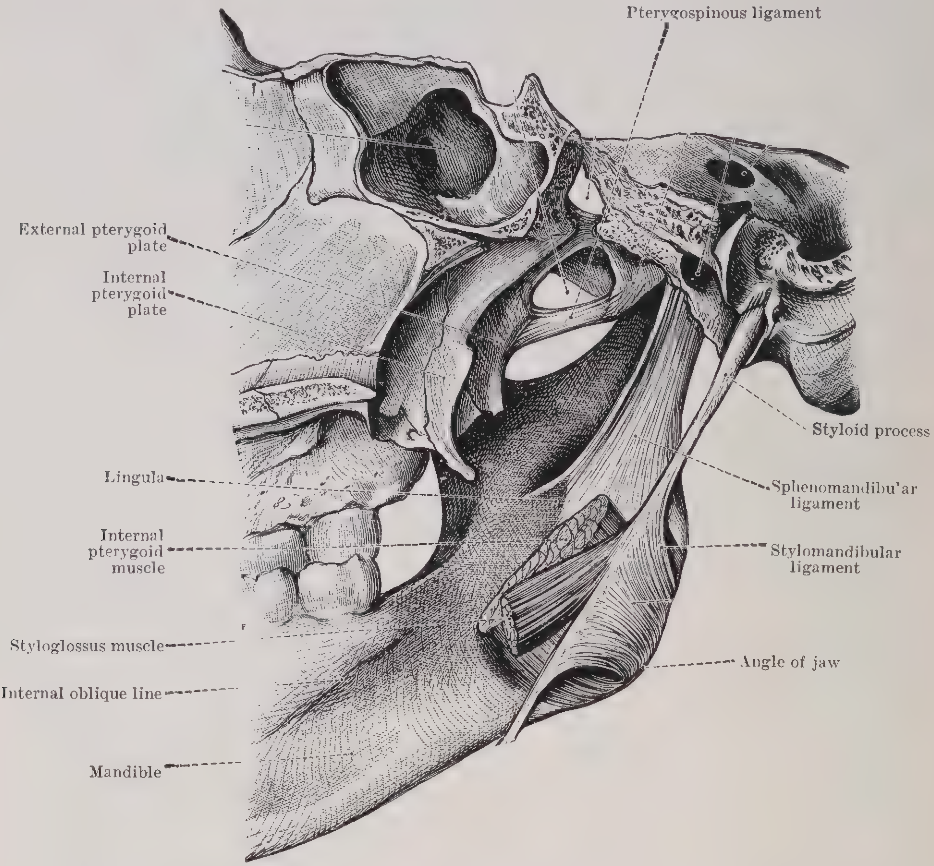

Pterygospinous ligament
External pterygoid plate
Internal pterygoid plate
Styloid process
Lingula
Sphenomandibu'ar ligament
Internal pterygoid muscle
Stylomandibular ligament
Styloglossus muscle
Angle of jaw
Internal oblique line
Mandible

FIG. 120. Temporomandibular articulation, showing the sphenomandibular or internal lateral ligament. (From Toldt's Anatomy.) In an incorrect insertion of the needle the ligament may be penetrated, resulting in after-pain.

During the entire injection the internal pterygoid muscle has not been entered, giving little pain to the patient.

Wrong Insertion on Wet Specimen.

Let us suppose that the needle has been improperly inserted on a line with the lower molar teeth and into the molar fold. (Figs 118 and 119.) The needle then enters the internal pterygoid muscle. The muscle is most likely injected and traumatized. Should an attempt be made to find the ascending ramus with the needle, the muscle must of necessity again be pierced to accomplish this. (Fig. 119.) In this last attempt the sphenomandibular or internal lateral ligament is penetrated. This ligament arises above from the spine of the sphenoid bone and is inserted below into the lingula. (Fig. 120.) Thus, the entrance into the muscle and the penetration of the sphenomandibular ligament produce trauma and are conducive to postinjection pains. Besides, the injection of the anesthetic solution into the internal pterygoid muscle produces edema and anesthetizes the motor nerve ending of the internal pterygoid branch of the anterior root of the mandibular nerve. These are the two main factors that produce temporary ankylosis, a condition which may persist from a few hours to a few days and in extreme cases, even longer. Another distinct disadvantage in an incorrect insertion is that the important structures, namely the lingual nerve and inferior dental artery may be encountered with the needle. (Fig. 119.) These structures, contrary to the belief of many, do not lie close to bone, but are away from the ascending ramus, resting upon the external surface of the internal pterygoid muscle. In a correct injection, therefore, the needle travels between these structures and bone, minimizing the chances of encounter. (Fig. 118.)

Mandibular Injection in a Sagittal Section.

Next, let us see this injection from another view. Fig. 121 represents a prepared anatomical specimen sectioned sagittally. On this side of the section the masseter muscle, the zygomatic arch, the upper part of the ramus and the external pterygoid muscle have been removed, while the temporal muscle has been deflected. In this manner the infratemporal region is exposed to view. The internal pterygoid muscle remains intact, together with the lingual and inferior dental nerves resting upon it. Fig. 121-1 shows the insertion of the needle. Observe the molar fold; observe also that the needle, striking bone, is inserted external to this fold. Now observe how the needle travels. Having released the needle from the periosteum, it is advanced to a depth of about 6 mm. and the lingual nerve is anesthetized. (Fig. 121-2.) The needle is in lateral contact with the external oblique line. Fig. 121-3 shows the needle in final position, striking the postero-lateral aspect of the mandibular sulcus. At this point the solution is injected to anesthetize the inferior dental nerve.

Mandibular Injection in a Sagittal Section, Internal View.

In the right section of the same anatomical specimen, only the internal pterygoid muscle has been removed in order to afford the student an internal view of the lingual and inferior dental nerves. The molar fold remains in position. Let us examine the injection from this viewpoint. Fig. 122-1 shows first, the proper insertion of the needle, which is external to the molar fold and on a horizontal line with the buccal surfaces of the lower teeth. Fig. 122-2 shows the injection for the lingual nerve, while Fig. 122-3 shows the injection for the inferior dental nerve. As the ascending ramus remains intact in this specimen, an opportunity is afforded to see how the needle is directed over the lingula. A clear view of the sulcus and the posterior border of the ramus is also obtained.

Too Low Insertion of the Needle in a Mandibular Injection.

To understand more clearly the importance of avoiding a too low insertion of the needle, the student is requested to compare carefully Figs. 113 and 123. Fig. 123 represents a horizontal section on a line with the occlusal surfaces of the lower teeth. At this level the internal pterygoid muscle seems to be closely adherent to the inner surface of the ascending ramus. Observe the almost uniform thickness of the ramus. At this level the mandibular sulcus has not as yet been formed. If the needle should be inserted at this plane, it will enter the insertion of the internal pterygoid muscle. No anesthesia will be produced, because the lingual and inferior dental nerves do not reach this level but are on a higher plane, in the pterygomandibular space, the former nerve running to the side of the tongue and the latter entering the inferior dental foramen to be distributed in the body of the mandible.

Observe also the compartment located posteriorly and internally to the internal pterygoid muscle and bounded posteriorly by the base of the skull, anteriorly by the internal pterygoid muscle and the superior constrictor of the pharynx and externally by the parotid gland and the external pterygoid muscle. In this compartment the vital structures are located, such as the internal carotid artery, the internal jugular vein and the vagus. These structures, however, are far away from the anesthetist's needle when making a proper mandibular injection. No fear whatever should be entertained as to the likelihood of entering or injuring these

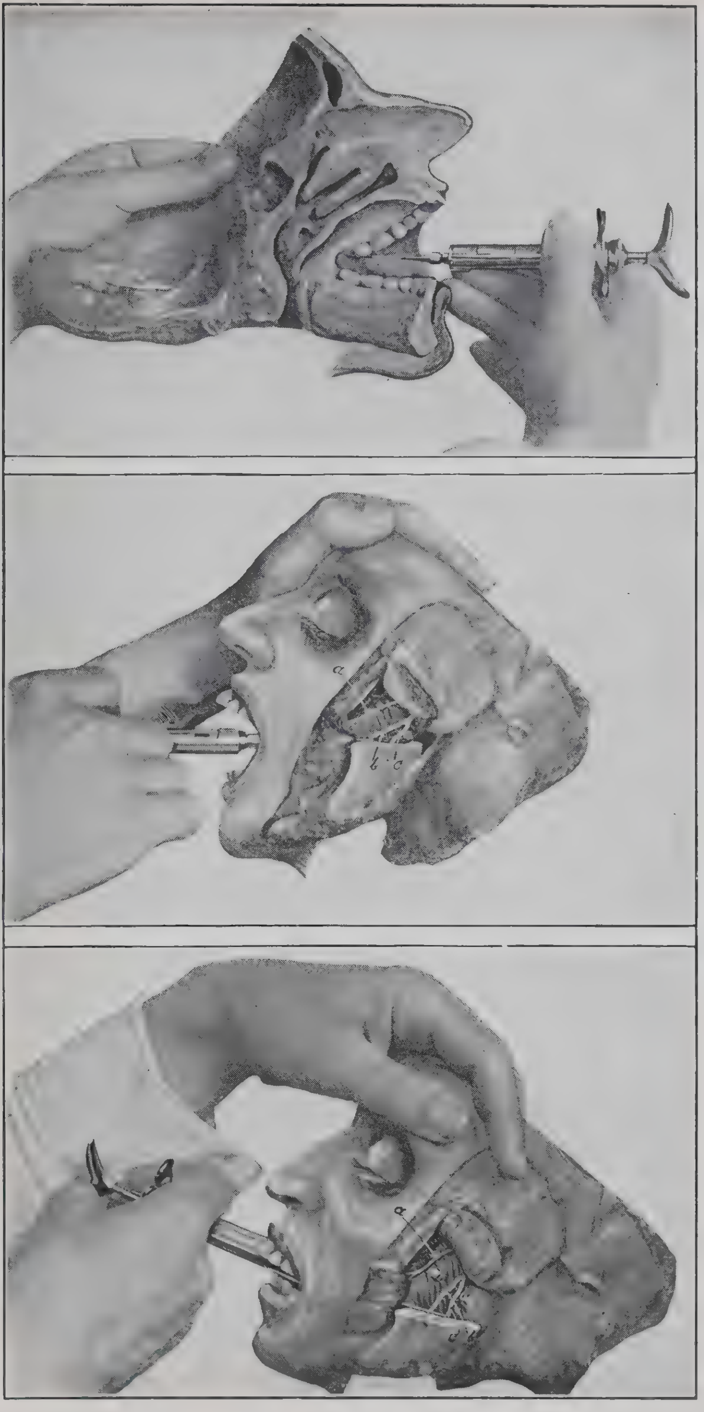


Fig. 121. Mandibular injection shown on a sagittal section of a prepared anatomical specimen. External view. A. Long buccal nerve. B. Lingual nerve. C. Inferior dental nerve. 1. Insertion of needle striking the internal oblique line. Observe the relation between the molar fold and the point of insertion. 2. Injection for lingual nerve. 3. Injection for inferior dental nerve.

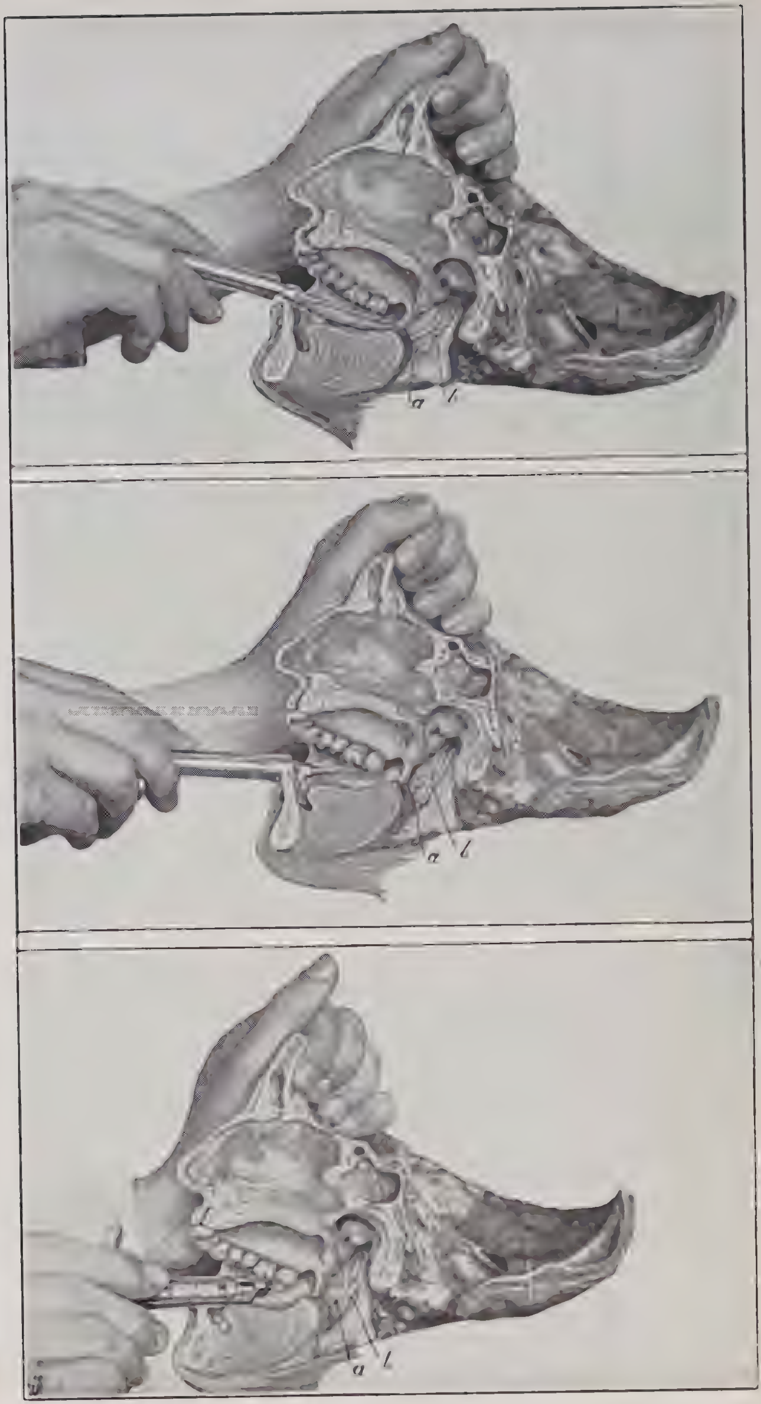
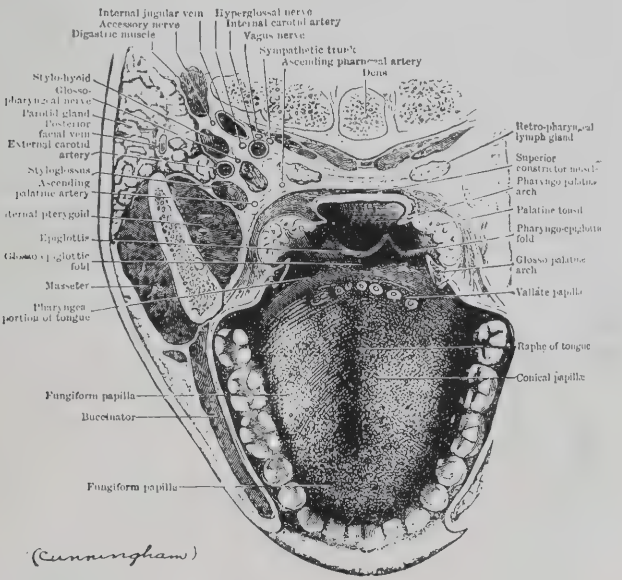


FIG. 122. Mandibular injection shown on a sagittal section of a prepared anatomical specimen. Internal view. Internal pterygoid muscle removed. A. Lingual nerve. B. Inferior dental nerve. 1. Insertion of needle striking internal oblique line. Observe molar fold. 2. Anesthetizing the lingual nerve. 3. Anesthetizing the inferior dental nerve.

structures. It will be observed from the illustration that a much longer needle than 42 mm. would be required and that the insertion must be made through the tonsils in order to reach this region.

On the other hand, Fig. 113 shows the plane at which the mandibular injection is made, namely about 1 cm. above the occlusal plane. At this level the inferior dental foramen and therefore the mandibular sulcus are found. The pterygomandibular space has already been formed and therefore the needle, when inserted at this level, will not be in the insertion of the internal pterygoid muscle but will glide above it in the space. The solution at this plane will reach the inferior dental and lingual nerves.


Internal jugular vein
Accessory nerve
Digastric muscle
Hyperglossal nerve
Internal carotid artery
Vagus nerve
Sympathetic trunk
Ascending pharyngeal artery
Dens
Stylo-hyoid
Glosso-pharyngeal nerve
Parotid gland
Posterior facial vein
External carotid artery
Styloglossus
Ascending palatine artery
Internal pterygoid
Epiglottis
Glosso-epiglottic fold
Masseter
Pharyngeal portion of tongue
Fungiform papilla
Buccinator
Fungiform papilla
Retro-pharyngeal lymph gland
Superior constrictor muscle
Pharyngo-palatine arch
Palatine tonsil
Pharyngo-epiglottic fold
Glosso-palatine arch
Vallate papillæ
Raphe of tongue
Conical papillæ

(Cunningham)

FIG. 123. A horizontal section on a plane of the occlusal surfaces of the lower teeth.

Having thus described the mandibular injection on the mandible and the prepared anatomical specimens and having a clear mental picture of the various structures and the course of the needle, one may confidently proceed with the injection on the patient, remembering that the technique already described applies to the patient as well. Every patient, no matter how thin or stout, how short or tall, has the same structures which we have described and explained. Every one has a mandible, an ascending ramus, an internal pterygoid muscle, a pterygomandibular space and a lingual and inferior dental nerve.

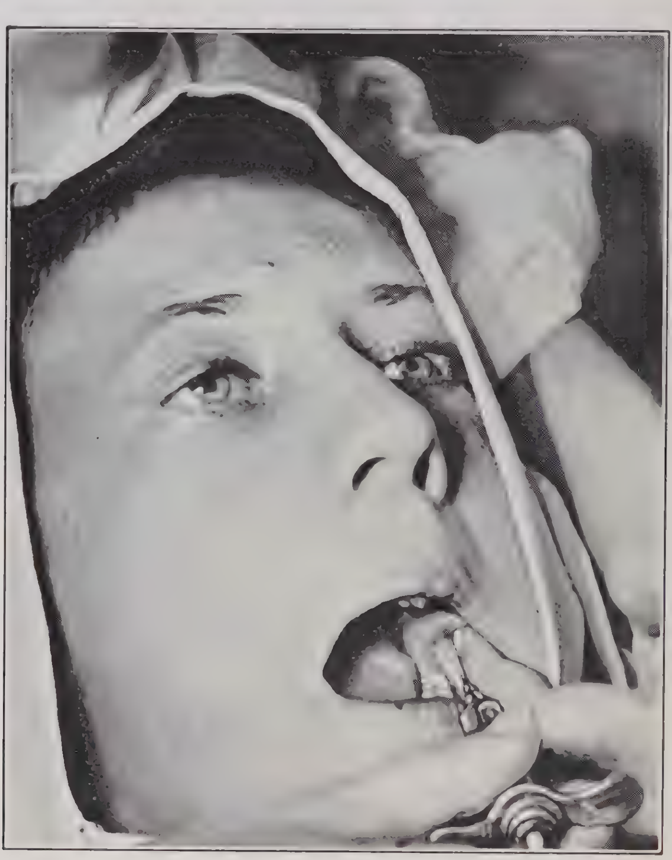


FIG. 124. Insertion of needle in a mandibular injection on the left side.

Injection on the Left Side.

The technique of injection on the left side of the mandible is the same as on the right except the manner of palpating the structures. This, however, is a question of convenience to the operator. Those operators who are able to manipulate the syringe with their left hand may palpate with their right index finger and inject with their left hand. The writer, being unable to inject easily with his left hand, palpates the external oblique line with the left hand, placing the bulb of his left index finger in the proper position. He then proceeds with the insertion of the needle with the right hand, crossing his arms. After beginning the injection the left hand is removed. Some operators find it convenient to place the left arm around the patient's head, palpate in this manner with the left index finger, injecting with the right hand. (Fig. 124.)

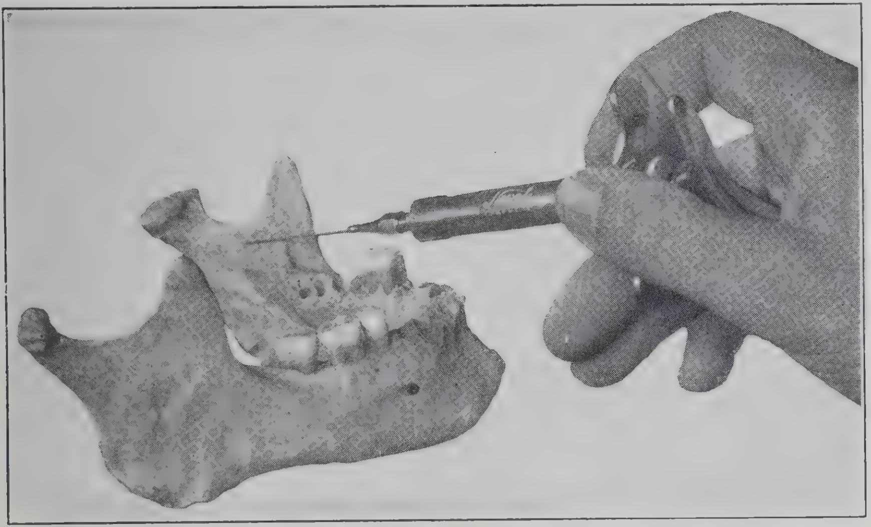


FIG. 125. In this mandible one-inch insertion of the needle from the soft tissues will not reach the inferior dental nerve.

Average Length of the Insertion of Needle.

While it may be true that in many cases a one-inch insertion of the needle may produce satisfactory results, nevertheless in an almost equal number of cases this rule will fail to produce anesthesia. In the writer's clinical experience the depth of the insertion of the needle in a mandibular injection has varied from less than one half inch, in a child of 6 years, to more than one and one half inches in an adult, entirely depending upon the width of the ramus and therefore upon the corresponding distance of the mandibular sulcus from the point of insertion. Fig. 103 illustrates the comparative width of two mandibles, one being 20 mm., while the other is 43 mm. wide. One-inch insertion from the soft tissues in one will not carry the needle far enough to reach the sulcus, and therefore no anesthesia will be produced; again one-inch insertion from the soft tissues in the other mandible may carry the needle too far back, past the posterior border of the ramus and into the parotid gland. (Figs. 125 and 126.) It is quite evident therefore that the only safe and certain guide as to the length of insertion of the needle is to find the posterior wall of the sulcus and then make the injection.

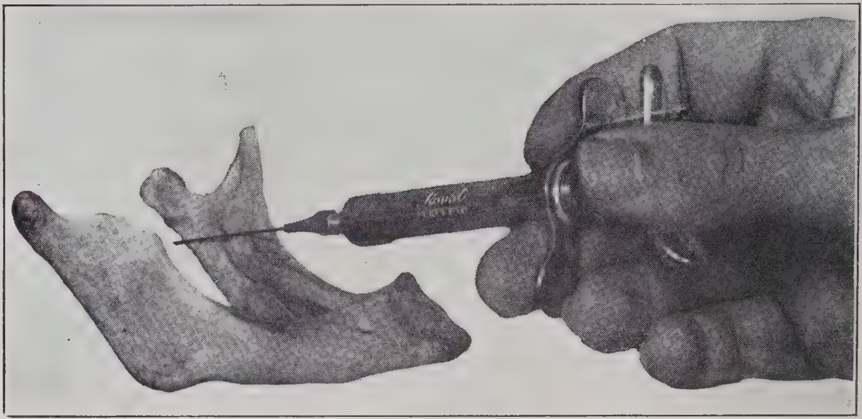


FIG. 126. One-inch insertion from the soft tissues in this case would carry the needle past the posterior border of the ascending ramus.

Clinical Cases.

Let us illustrate this with a few cases in actual practice. In one of the clinics an elderly negro of small stature presented for the extraction of a lower molar tooth. A mandibular injection was made without obtaining anesthesia. The approximate width of the mandible was then obtained by placing the thumb on the anterior border of the ramus and the index finger on the posterior border. (Fig. 127.) The ramus was found to be of an unusual width. Another injection was made; this time care was taken to find the posterior boundary of the mandibular sulcus with the needle. To do this it was necessary to insert the entire length of the 42 mm. needle and even part of the hub. Complete anesthesia followed in five minutes.

Another case was that of a young lady of 22 upon whom three attempts were made to anesthetize a lower first molar by a mandibular injection, but without success. After the last injection, an attempt was made to remove the tooth, but on account of the intense pain, the operation was abandoned after the crown of the tooth had been broken off. The young operator who brought the patient to the clinic told the writer that this was his first complete failure to obtain anesthesia in a mandibular injection. He then proceeded to make the injection under the writer's direction. The ramus was measured and found to be extremely narrow. Less than three-quarters of an inch of the needle had to be inserted in order to reach the mandibular sulcus, with the result that complete anesthesia followed in a comparatively short time. In the previous injections the needle had been inserted too far posteriorly and the injections had been made into the parotid gland.

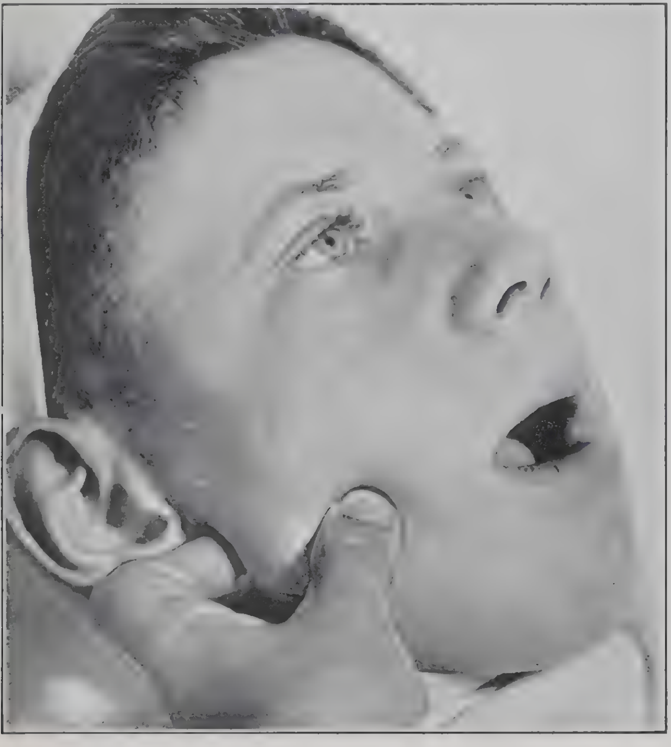


FIG. 127. Determining the approximate width of ramus.

These are only two of numerous cases that have come to the writer's attention, which illustrate the necessity of reaching the mandibular sulcus before an injection is made and of not relying upon a definite length of the needle insertion, irrespective of the various types, sizes and widths of the ascending rami.

The writer has measured a great many mandibles on the dry skull, as well as on living subjects, and found them to vary in width from 18 mm. to 44 mm.

The Importance of Striking the Mandibular Sulcus in a Pterygomandibular Injection

There are a few other good reasons why the mandibular sulcus should be sought with the point of the needle before the injection is made. Let us enumerate these as follows:

1. To avoid the internal pterygoid muscle.
2. To avoid the masseter muscle.
3. To avoid the parotid gland.
4. To avoid the posterior facial vein.
5. To avoid the facial nerve.

We shall take these up one by one.

How to Avoid the Internal Pterygoid Muscle.

The needle gliding into the pterygomandibular space and finally striking the sulcus is a sure indication that the muscle has been cleared. There is nothing to indicate that we are not depositing the solution into the muscle unless the needle point comes in contact with bone before the ejection of the solution. We are taking for granted, of course, that the injection has been made at a proper height and that the sulcus and not the area below was encountered. But by inserting the needle only up to a certain length and in a certain direction without this precaution, what assurance have we that the needle is not embedded in the internal pterygoid muscle and the solution deposited therein? When this happens, edema is generally established, resulting frequently in postoperative pain and temporary ankylosis.

How to Avoid the Masseter Muscle.

The masseter muscle may be injected by a too high insertion of the needle, particularly in cases where the sigmoid notch is low. Fig. 128 shows a mandible where a mistake of this kind is likely to happen, particularly when the injection is to be made on the left side. The molar tooth is elongated on account of loss of the opposing teeth in the upper arch. The correct height of the needle insertion relative to the occlusal plane of the molar has therefore been lost. This, combined with the unusually low sigmoid notch, may lead the anesthetist to direct his needle through the notch and into the masseter muscle. A mistake of this kind would be followed by a shooting pain in the ear and a troublesome case of false ankylosis. This mistake can be avoided with certainty if the operator were looking for the mandibular sulcus. He surely could not find it by going through the sigmoid notch. If he is cautious he would withdraw his needle and by palpating the depression on the anterior border of the ramus, direct his needle at its deepest point. This would take him to the proper point for the injection of the solution. Fig. 129 shows the correct plane of direction of the needle. It will be observed that in this abnormal case the correct plane is below the occlusal surface of the molar tooth.

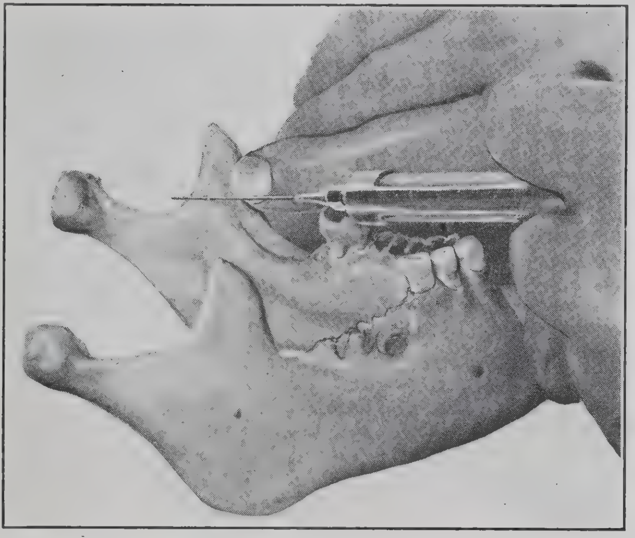


Fig. 128. Wrong insertion into masseter muscle.

How False Ankylosis is Obtained.

The opening and closing of the mouth is effected in the following manner: The weight of the mandible, combined with the contraction of the suprahyoid and infrahyoid muscles, causes the depression of the mandible and the opening of the mouth. The relaxation of the masseter and internal pterygoid muscles are necessary for this accomplishment. The elevation of the mandible and the closing of the mouth is accomplished by the relaxation of the infrahyoid and suprahyoid muscles and the contraction of the internal pterygoid and masseter muscles in conjunction with the temporal. When the anesthetic solution is injected into the internal pterygoid or masseter muscles, their motor nerve endings are anesthetized, resulting in loss of their normal function, namely, contraction and relaxation. These muscles, under the circumstances, cannot relax to permit the depression of the mandible. The established edema is a contributory factor in this phenomenon also.

How to Avoid the Parotid Gland.

If the needle should be progressed too far posteriorly, past the posterior border of the ascending ramus, the parotid gland will be entered and the anesthetic solution discharged therein. This is possible only when the sulcus is not encountered by the needle, which is permitted to glide too far back. The writer believes that a great many mandibular injections are made into the parotid gland unnecessarily. The injection into the gland itself does not appear to be followed by any ill effects. There is a possibility, however, of encountering the posterior facial vein or of anesthetizing the facial nerve. Anesthesia of the inferior dental nerve is seldom obtained in such cases. The anesthetic solution, by diffusion, may sometimes reach the inferior dental nerve and produce partial anesthesia, but only after a lapse of considerable time following the injection.

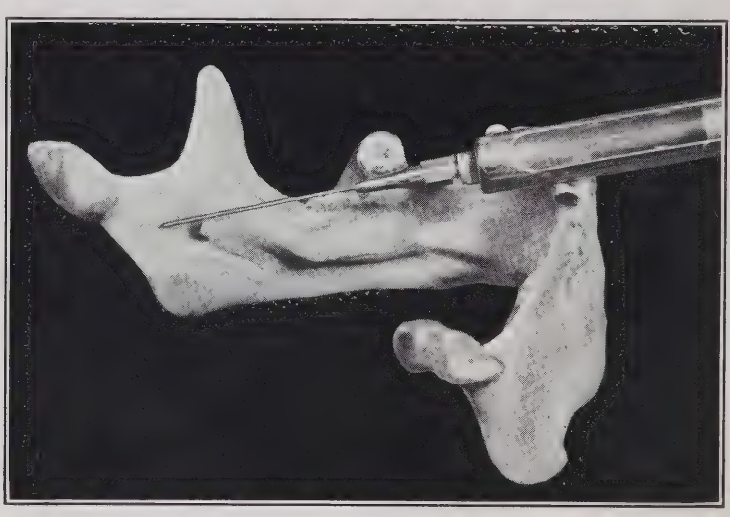


FIG. 129. Correct insertion shown on the same mandible.

How to Avoid the Posterior Facial Vein.

The posterior facial vein is embedded in the substance of the parotid gland and is just on a line with the path of the needle, in a mandibular injection, should it be allowed to progress too far and beyond the ramus. (Figs. 26 and 119.) The needle may enter the posterior facial vein and the solution be injected intravenously. The toxicity of the anesthetic is greatly increased. The patient, in such cases, may manifest characteristic toxic disturbances, such as perspiration, trepidation, or pallor. These are frequently followed by digestive distress, nausea and even fainting. It is quite obvious that by avoiding the parotid gland, the possibility of entering the posterior facial vein will be entirely eliminated. The needle striking the posterior boundary of the mandibular sulcus, assures the anesthetist that the parotid gland has not been entered.

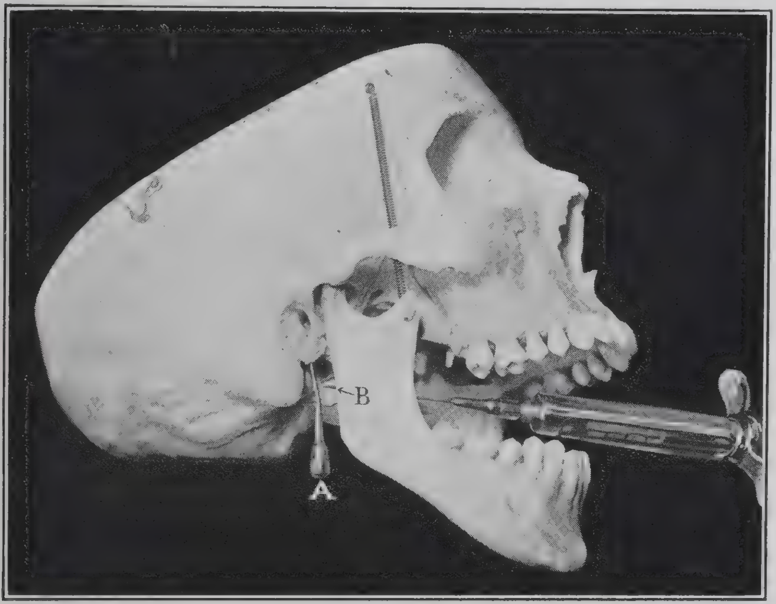


Fig. 130. A. Needle inserted into the stylomastoid foramen, indicating the emergence of the facial nerve from the cranium. B. Needle inserted too far back in a mandibular injection may anesthetize the facial nerve A.

How to Avoid the Facial Nerve.

It will be remembered that the facial nerve, after leaving the cranium by the stylomastoid foramen, is embedded in the parotid gland. Its two main branches, the temporofacial and cervicofacial, radiate from the main trunk. Fig. 130 shows how it is possible, by incorrectly directing the needle into the parotid gland in the mandibular injection, to anesthetize either or both branches. This will result in blocking their efferent motor endings, with a consequent loss of normal action of the muscles of expression, which these nerves supply. Should the cervicofacial branch only be anesthetized, there will be a relaxation and consequent drooping of the lower lip. If the injection be made a little higher, the temporofacial branch of the facial nerve may be anesthetized, so that there will be drooping of the upper lip. The patient in such cases will sometimes be unable to close the lower eyelid, due to blocking the motor impulses to the orbicularis palpebrarum. Should the entire facial nerve be anesthetized, all the muscles on that side of the face will relax. (Fig. 44.) This condition is known as facial paralysis and persists only as long as the anesthesia is maintained. Sometimes, however, the anesthetic solution retained in the parotid gland may exert its influence upon the facial nerve for several days, thus prolonging the paralysis of the muscles of expression. The drooping of the upper lip is very characteristic in a correctly performed infraorbital injection. In a mandibular injection, however, it would indicate incorrect technique. In the former case the terminal branches of the temporofacial division of the facial nerve are anesthetized at the infraorbital foramen, while in the latter this condition would indicate that the temporofacial nerve is blocked in the parotid gland by the failure to find the mandibular sulcus, thus inserting the needle too far back.

Symptoms and Tests.

Symptoms in Mandibular Anesthesia.

The first symptoms of anesthesia will be manifested at the lips. The patient will complain of a peculiar feeling either at the median line or at the corner of the mouth. This sensation will gradually become more intense. If the injection has been correctly performed, profound anesthesia will be obtained in from five to ten minutes. The patient is first aware of the anesthesia in the lip because this structure is more responsive to the blocking of the afferent impulses at the mandibular sulcus than is the mandible itself. Anesthesia does not take place at first in the lips as some anesthetists believe. Anesthesia, once established, will last from one to three hours.

Testing for Extent of Anesthesia.

After the injection has been made and symptoms observed, the mucous membrane must be tested for the extent of anesthesia obtained. The symptoms alone are not sufficient, for the patient is often unable to analyze his own sensations because of the psychic effect of the impending operation.

The mucous membrane is tested lingually to determine whether the lingual nerve has been anesthetized. Pressure is exerted by the points of a pair of cotton pliers or other suitable instrument. Next, the buccal mucous membrane of the molars is tested. If there is no pain, it would indicate that the long buccal nerve has been anesthetized and nothing else. The inferior dental nerve may have been anesthetized and, on the other hand, it may not have been reached by the solution. The writer has had many cases in his clinical experience where the long buccal nerve has been anesthetized while the inferior dental nerve has not. Anesthesia of the long buccal nerve is necessary only when the lower molar teeth are to be extracted. We next test the anesthesia of the buccal mucous membrane between the bicuspid teeth, or between the cuspid and first bicuspid. When there is no response to this test we know that the inferior dental nerve has been blocked. It must be remembered that the buccal mucous membrane of the bicuspids is supplied by the mental nerve and if this nerve does not respond to stimulation, it naturally follows that the inferior dental nerve has also been anesthetized by the injection, since the mental nerve is a branch of the inferior dental.

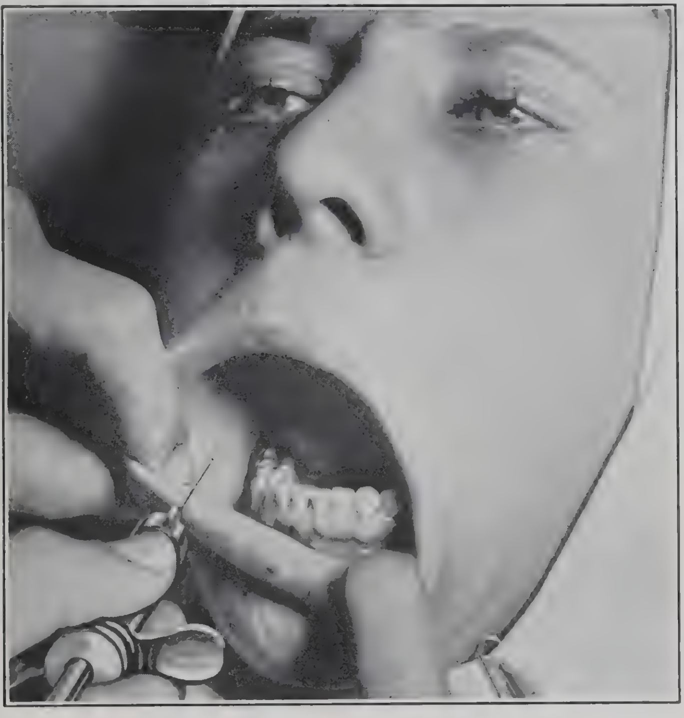


FIG. 131. Blocking the long buccal nerve.

The numbness of the tongue does, of course, indicate that the lingual nerve has been anesthetized. The dryness of the mouth after a mandibular injection is due to the blocking of the chorda tympani, a secretory nerve and a branch of the facial. This nerve joins the lingual and they run together to the tongue and to the submaxillary gland, controlling the secretion of the saliva. When the lingual nerve is anesthetized, the chorda tympani is also frequently blocked, with the resultant interference of salivary secretion. Hence dryness of the mouth.

Anesthesia of the Long Buccal Nerve.

It has never been satisfactorily explained why the long buccal nerve is often anesthetized by a mandibular injection or why it remains unanesthetized just as often. Some maintain that this phenomenon is due to the fact that the long buccal nerve may sometimes be given off at the inferior dental foramen and is therefore anesthetized by a mandibular injection together with the inferior dental. It is the writer's opinion that the long buccal nerve is constant in so far as its origin is concerned, namely, it is given off from the anterior root of the mandibular nerve almost as soon as it leaves the cranium by the foramen ovale. Its course, however, toward the cheek is not constant. Sometimes the long buccal nerve may run along the anterior border of the ramus or just slightly internally to it. In such cases the nerve will be anesthetized by the injecting solution intended for the lingual nerve. At other times the course of the long buccal nerve is more internally, along the tuberosity of the superior maxillary bone, before its ramification into the buccinator muscle. In such cases a lingual or mandibular injection will fail to reach it and therefore anesthesia of the buccal mucous membrane of the lower molar teeth will not be obtained.

Technique.

If the long buccal nerve remains unanesthetized, the anesthesia of the molar teeth may be completed, in the absence of infection, by a submucous injection of the buccal mucous membrane of the area to be operated on. But in cases of infection, infiltration into the inflamed and infected area is contraindicated. The long buccal nerve is then anesthetized in the following manner. A long, 42 mm. (1⅝") 23 gauge needle is inserted just beneath the mucous membrane of the buccinator muscle, beginning at the first molar tooth on a plane of the occlusal surfaces of the lower molar and bicuspid teeth. The needle is then advanced posteriorly, injecting the solution as the needle progresses until the postmolar fossa is encountered, where about 1 cc. of the anesthetizing solution is deposited. This will generally anesthetize the terminal branches of the long buccal nerve or it may block the main branch of the nerve which supplies the buccal mucous membrane of the lower teeth. In this injection care must be taken not to insert the needle deeply into the muscle fibers of the buccinator muscle. Also not to insert the needle at too high a plane, for fear of entering Stenson's duct and discharging the solution therein. About 1 cc. of a 2% procaine solution is deposited in this injection. (Fig. 131.)

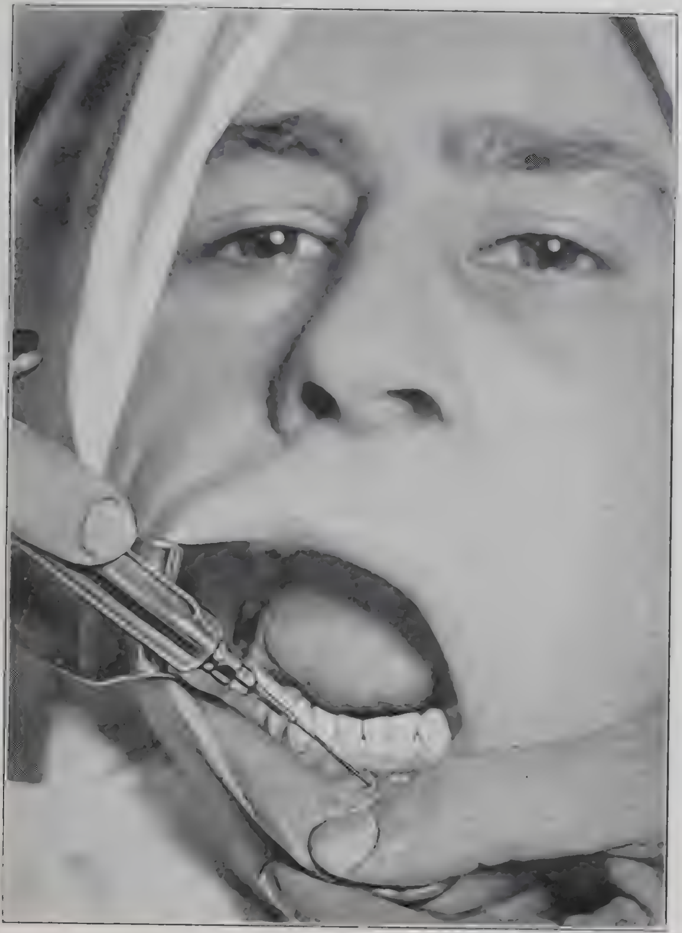


FIG. 132. Blocking anastomosis from opposite side.

Blocking Interlacing Branches from the Opposite Side.

When it is intended to operate up to the median line, the communicating branches from the opposite incisive and mental nerves must be blocked to assure a completely painless field. The opposite terminal branches are carried to the central and lateral incisors and frequently as far as the cuspid tooth. Formerly, the writer would complete the anesthesia by an opposite mental injection, but more recently this method of blocking the anastomosis has been abandoned. Instead, the solution is deposited for this purpose at the mental or incisive fossa, but not at the mental foramen.

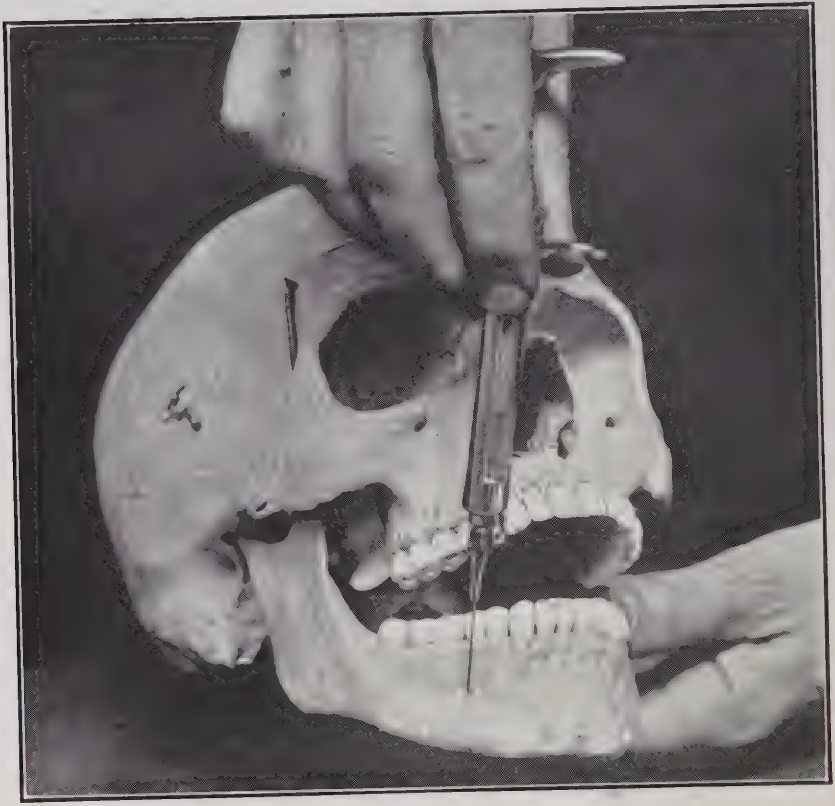


FIG. 133. Mental injection shown on skull.

Technique. A 25 mm. (1″) 23 gauge needle is employed for the injection into the mental fossa. The needle is inserted in the median line facially, between the apices of the lower central incisor teeth, at the reflection of the mucous membrane. It is then directed to the opposite mental fossa, which is located between and below the apices of the lateral and cuspid teeth, endeavoring to keep the needle close to bone and beneath the periosteum. About 1 cc. of a 2% procaine solution is here deposited. The mental fossa will be found to be rich with small foramina. The solution will anesthetize the mental nerve and will be carried through the small foramina to the mandibular canal, blocking the opposite incisive nerve. (Fig. 132.)

Mental Injection.

The writer has, of late, abandoned the mental injection for the following reasons:

The difficulty of reaching the mental foramen on account of its orifice opening posteriorly. The mental foramen, unlike the infraorbital, is not marked by a depression. This makes it difficult to palpate. The injecting solution therefore finds its way with difficulty into the foramen, so that satisfactory anesthesia of the incisive nerve is seldom obtained. The writer has found also, in his clinical experience, that this injection is followed by considerable soreness, which appears to be due to the fact that the solution is too often injected into muscles attached to the body of the mandible in close proximity to the mental foramen. These muscles are the platysma myoides, depressor anguli oris and depressor labii inferioris. The avoidance of these muscles is difficult, if not impossible.

Anesthesia of the lower teeth may be obtained without the necessity of resorting to a mental injection. The blocking of the communicating branches from the opposite side may be accomplished in the manner described above. The bicuspids and anterior teeth may be anesthetized much more easily and with more certain results by a mandibular injection.

Technique of Mental Injection.

The technique of the mental injection is as follows: Standing on the right side of the patient with the left arm around the patient's head, the mental foramen is palpated by the left index finger and the lip is deflected with the thumb. The syringe with a 25 mm. (1″) needle is picked up by the right hand in a pencil-like manner and the needle inserted at the reflection of the mucous membrane between the two bicuspid teeth. The needle is directed slightly posteriorly, gradually advancing it downward and backward and slowly injecting. When the solution will be felt by the bulb of the palpating index finger, the remainder of a 2 cc. syringeful of a 2% procaine solution is injected. The area around the mental foramen is then massaged forward, endeavoring to drive the solution into the mental foramen. The area anesthetized, if the injection be successful, will be the bicuspids and anterior teeth and lower lip from the mental foramen to the median line. The lip is generally anesthetized by a mental injection but the solution does not always enter into the foramen and therefore the bicuspids and anterior teeth are not always anesthetized. (Figs. 133 and 134.)

Mandibular Anesthesia in Children and Old People.

The inferior dental foramen in children is lower than in adults, while in the aged it is higher, particularly in edentulous mouths. However, the depression in the anterior border maintains its relative plane to the mandibular sulcus and the deepest point of this depression will correspond to a point in the mandibular sulcus just above the lingula.

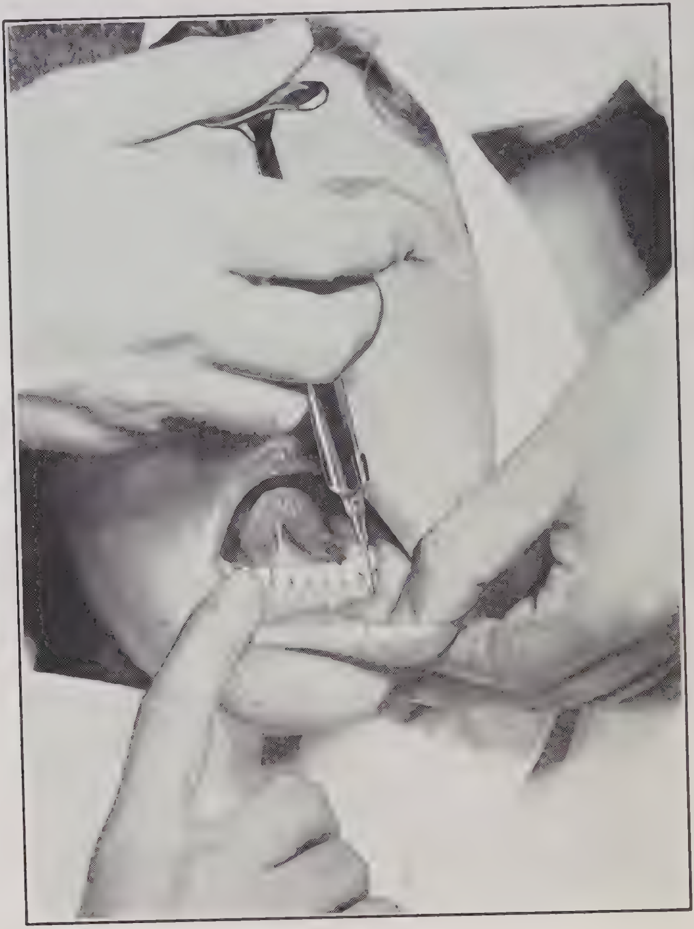


FIG. 134. Mental injection shown on patient.

As the ascending ramus develops in a growing child, this depression in the anterior border develops in the same proportion with the mandibular sulcus. And, as the adult advances in age, the relative position of the sulcus and the deepest point of the depression in the anterior border is maintained as the changes in the ascending ramus and the body of the mandible progress.

CHAPTER VI.

EXTRAORAL INJECTIONS.

Occasions arise when nerve blocking injections must be made extraorally, instead of within the vestibule of the mouth, or the mouth proper. In cases of wounds, accidents, ankylosis, swellings, etc., when the opening of the mouth is very painful, or else entirely impossible, heroic measures sometimes become imperative. In such cases the ability to perform an extraoral injection is of inestimable value to the dentist and a blessing to the patient. This particularly applies to some of our fellow practitioners in small communities who have not the advantage of easy access to specialists that their city brothers enjoy.

Extraoral injections are not any more difficult than intraoral and their technique may be mastered just as readily. They have the advantage of easier accessibility and the comparative ease with which asepsis may be maintained. Larger areas may be anesthetized. If it were not for the sentimental attitude against extraoral injections by the operator as well as by the patient, extraoral injections would be made much more frequently and with very gratifying results.

Extraoral Infraorbital Injection.

This injection is very valuable to the dental surgeon. The anesthetic solution may be injected directly into the infraorbital canal, anesthetizing the entire infraorbital nerve, and the entire outer nerve loop. If the infraorbital foramen is large, so that the infraorbital canal is easily entered, the solution will, by propulsion and diffusion, frequently reach Meckel's ganglion, thus blocking also the inner nerve loop.

When Indicated.

Very often patients present themselves with an inflamed and infected area involving the bicuspids and also the anterior teeth. Intraoral infraorbital injection in such cases is precluded, on account of the possibility of carrying the infected matter still further with the point of the needle. It is in such cases that extraoral infraorbital injections should be made.

Landmarks. With a very fine camel's-hair brush, dipped in a weak solution of tincture of iodin, or some other coloring fluid, easily effaced, the infraorbital ridge is outlined on the patient's face. A vertical line is then drawn, beginning at the infraorbital ridge, and on a line from the pupil of the patient's eye to the long axis of the second bicuspid tooth. On this vertical line about 7 mm. (¼″) below the junction of the two lines, a cross is made to indicate

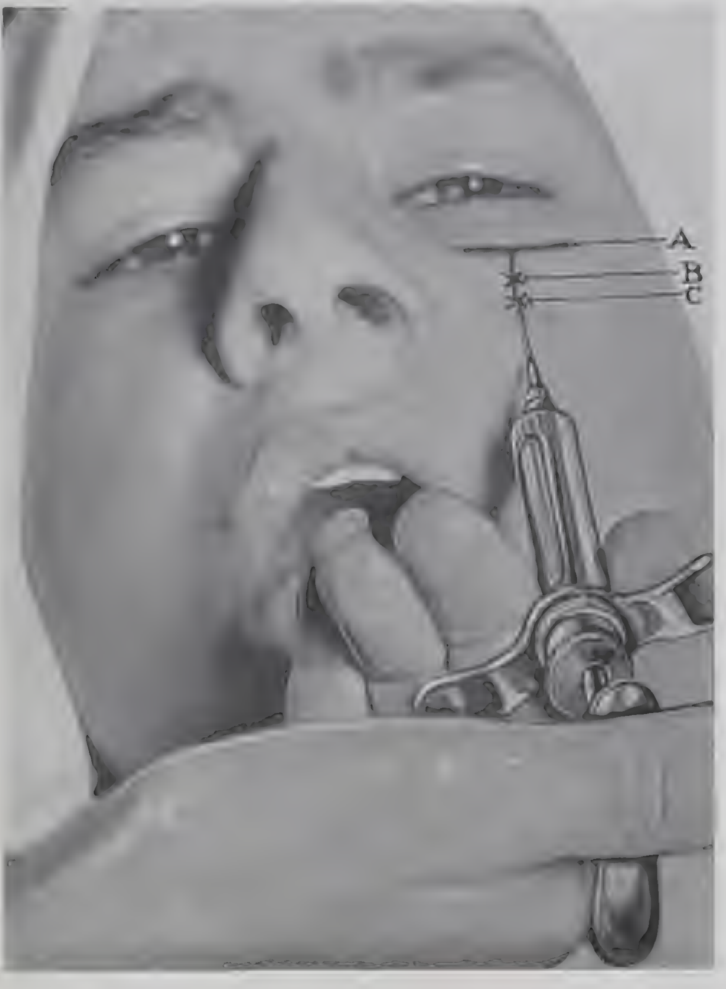


FIG. 135. Extraoral infraorbital injection. A. Infraorbital ridge. B. Point corresponding to the infraorbital foramen. C. Point of needle insertion.

the approximate position of the infraorbital foramen. Then another point is marked on the vertical line one-quarter inch below the first point. (Fig. 135.)

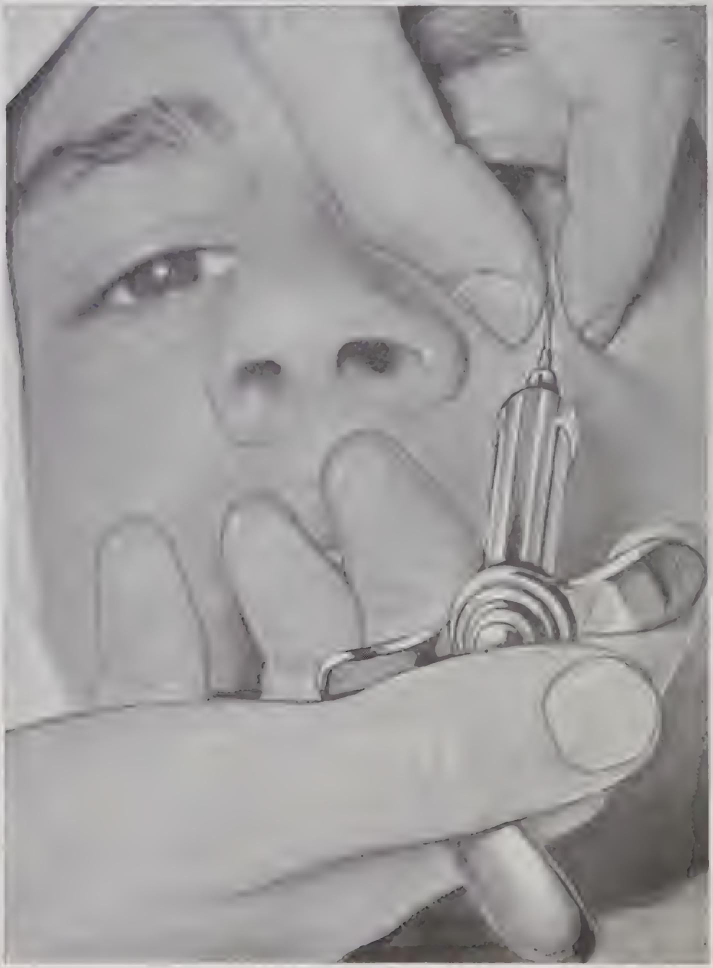


Fig. 136. Insertion of needle in an extraoral infraorbital injection.

Preliminary Precautions.

Thorough asepsis must be maintained. The site of the injection is washed with a 1 : 1000 bichlorid solution, followed by painting with tincture of iodin, or one part of tincture of iodin and two parts of acetone.

Needle Employed. The needle employed for this injection is a 25 mm. (1″) 25 gauge, preferably of iridio-platinum.

Technique. The skin and subcutaneous tissues are lifted between the thumb and the index finger at a point corresponding to the lower mark on the vertical line. The needle is inserted at this point, which will be about half an inch below the infraorbital ridge. (Fig. 136.) The needle is directed at an acute angle of about 45° toward the surface of the skin and inserted into the tissues. As the foramen opens downward, the needle should be directed to the mouth of the foramen. A few drops of the anesthetic solution are injected and after waiting about 30 seconds to establish superficial anesthesia and insure painless progress of the needle, it is advanced further until bony structure is en-

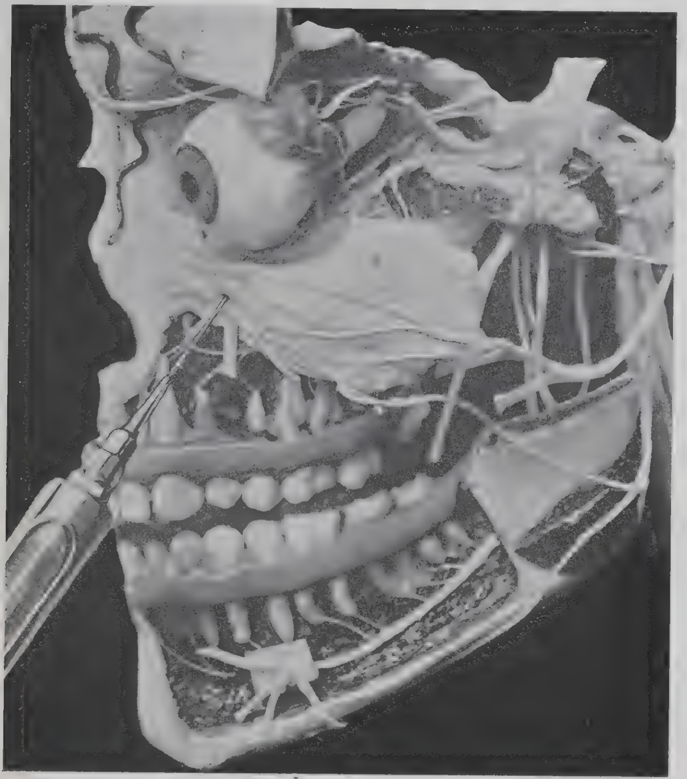


FIG. 137. Position of needle in an extraoral infraorbital injection on anatomical specimen. Note position of needle at an angle of about 45° to the cheek.

countered. Here another ten drops of the solution are slowly injected. The needle is now in the proximity of the infraorbital foramen. After the lapse of another minute, in order to establish partial anesthesia of the surrounding structures, the orifice of the infraorbital foramen is sought with the point of the needle and entered for a distance of about 6 or 7 mm. (¼″), and the remaining solution of a 2 cc. syringeful slowly injected. (Fig. 135.) It is good practice here to pull the plunger slightly back, before injecting the anesthetic solution into the infraorbital canal, in order to determine whether a blood vessel has been entered. The constricted infraorbital canal will offer the needle a splendid opportunity to enter the infraorbital vein and thus deposit the solution intravenously. If a vein is entered, the position of the needle is slightly changed, tested again and the solution injected. The skin over the infraorbital foramen is massaged to facilitate the diffusion of the solution through the infraorbital canal. The needle is generally inserted anywhere from a half to three quarters of an inch, depending entirely upon the thickness of the bundles of muscle fibers and the quantity of adipose tissue through which it must pass to reach the infraorbital foramen. (Fig. 137.)

Area Anesthetized. If the infraorbital foramen has been entered, the entire outer nerve loop will be anesthetized. There is also a likelihood of the solution reaching the pterygopalatine fossa and anesthetizing Meckel's ganglion. Anesthesia will be more profound and of longer duration than that of an intraoral infraorbital injection.

Blocking the Anastomosis. When it is desired to operate to the median line, the interlacing branches of the opposite infraorbital nerve must be blocked. This can be accomplished by infiltrating the area above the central tooth to be operated on. In presence of infection or inflammation, infiltrate the area above the central tooth of the unanesthetized side or make an opposite infraorbital injection.

Extraoral Injection for the Superior Maxillary Nerve.

The second division may be anesthetized extraorally by passing the needle through the buccinator muscle into the infratemporal fossa and thence into the pterygopalatine (sphenomaxillary) fossa where the solution is deposited.

When Indicated. This injection is useful when the patient cannot open his mouth, because of infection or injury, or when infected and inflamed areas make it inadvisable to perform an intraoral injection. Also, in cases where extensive operations are contemplated, such as radical operations upon the antrum of Highmore or removal of the superior maxillary bone in malignant growths, etc. In such cases more profound anesthesia, extending over a larger area, is desirable.

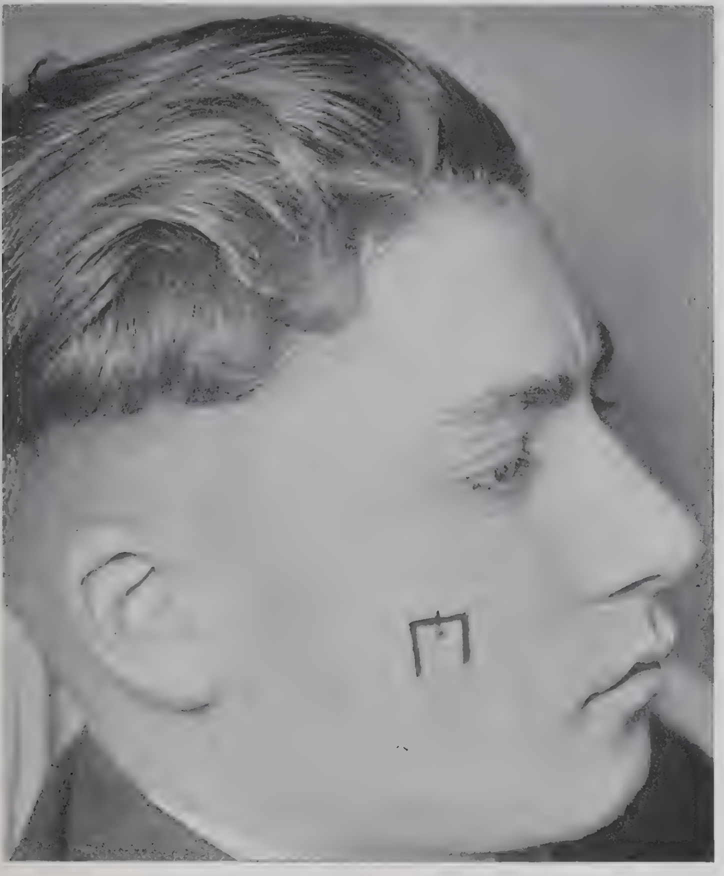


FIG. 138. Landmarks in an extraoral tuberosity and superior maxillary nerve injection, showing point of insertion of needle.

Landmarks. The anterior border of the ascending ramus and the coronoid process are palpated extraorally and outlined on the cheek with a fine brush dipped into a weak solution of tincture of iodin. By having the patient gently open and close his mouth, provided the condition of the patient permits this, the anterior border of the ramus may easily be located. Next, the root of the malar process of the superior maxillary bone is palpated. This will correspond in an adult, to the apices of the second upper molar tooth. A second vertical line is drawn on the patient's face from the root of the malar process downward. The two lines are connected above by a horizontal line, joining these two lines and outlining the lower border of the malar bone. This line is equally divided. The needle is inserted just slightly below the point of division. (Fig. 138.)

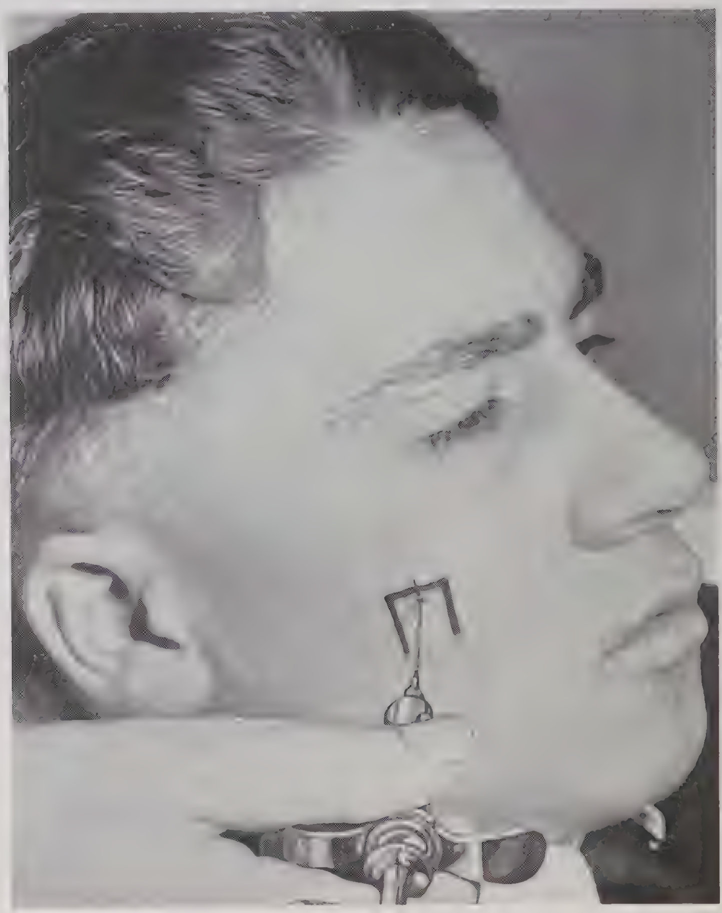


FIG. 139. Insertion of needle in an extraoral second division injection.

Needle Employed.

For this injection a 20 gauge steel needle 75 mm. (3″) long is generally used. The needle is usually inserted to a depth of about 50 mm. (2″) so that

25 mm. will remain outside the tissues. A 25 mm. (1″) 25 gauge needle may be used for preliminary injection.

Technique. The patient's head is tipped slightly on one side, the operator standing on the right side of the patient. This injection, however, is best performed with the patient lying on an operating table. The site of the injection is prepared by thoroughly cleansing and painting it with tincture of iodin or some other suitable antiseptic agent. The skin in the area outlined is lifted by the left thumb and index finger and about 1 cc. of a 2% procaine solution injected with the 25 mm. needle, thus establishing a wheal and anesthesia of the subcutaneous tissues, so that the major injection may be painlessly performed. After waiting about a minute, the 75 mm. needle is inserted at the point described above. (Fig. 139.) The needle is directed horizontally at right angles to the cheek. At a depth of about 25 mm. the tuberosity of the superior maxillary bone is encountered. (Figs. 139 and 140.) If it is desired only to anesthetize the upper molar teeth, about 2 cc. of the anesthetic solution may be deposited here and the needle withdrawn. For

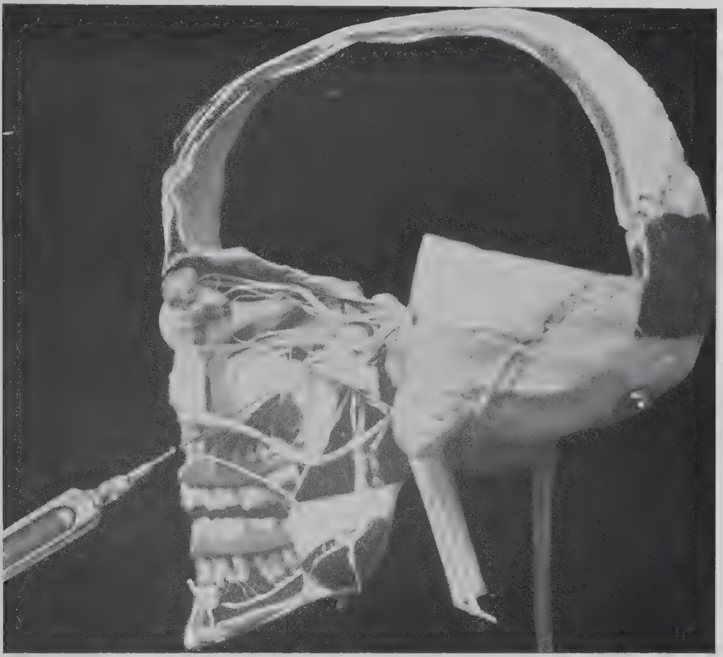


FIG. 140. Position of needle in an extraoral tuberosity injection.

blocking the entire superior maxillary nerve, the needle is disengaged from the periosteum of the tuberosity and it is directed slightly backward, clearing the tuberosity, and then upward to an entire depth of about 50 mm., when bone will again be encountered. If the needle has been properly directed, the point will be in the pterygopalatine fossa, the under surface of the greater wing of the sphenoid will have been encountered, just below the foramen rotundum. If bone is not encountered at a depth of 50 mm. (2″) it should be slightly withdrawn and the point of the needle directed slightly lower. By directing the needle too high, there is a possibility of passing through the sphenomaxillary fissure at the back of the orbit. It is good practice to attach a piece of unvulcanized rubber or a metal disc at the 50 mm. point of the needle so that the anesthetist will know how far his needle has been inserted. If the needle is directed too far backward the external surface of the pterygoid plate may be encountered. By carrying the needle along the zygomatic surface of the superior maxillary bone this can be avoided. In doing so, however, care must be taken not to engage the periosteum. Should the needle strike the external pterygoid plate, it should be slightly with-

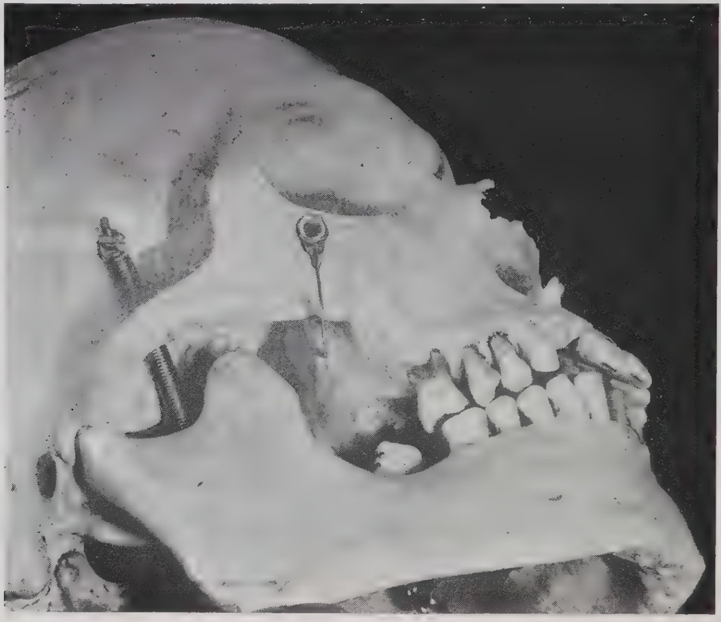


FIG. 141. Position of needle in an extraoral tuberosity injection shown on prepared anatomical specimen.

drawn and directed more anteriorly, feeling for the anterior border of the external pterygoid plate, and in this manner, finding its way into the pterygopalatine fossa. The syringe should be frequently tested to determine whether a blood vessel has been entered, for it must be remembered that the infratemporal fossa is highly vascular. The pterygoid plexus of veins is in the fossa and the internal maxillary artery may be encountered by the needle in its course to the pterygopalatine fossa. (Figs. 141, 142 and 143.)

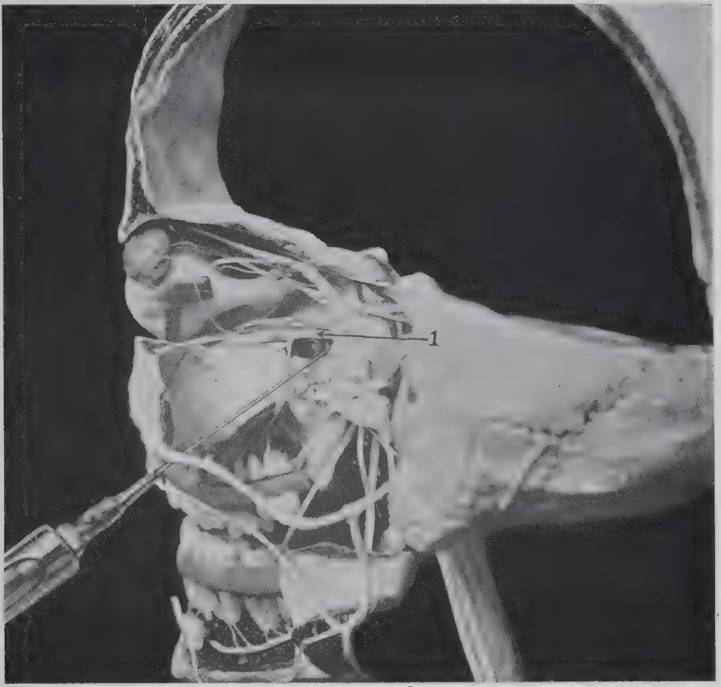


FIG. 142. Final position of needle in an extraoral second division injection. Note needle is just below foramen rotundum.

A few drops of the anesthetic solution are deposited as the needle is being inserted so as to insure a painless path. In the pterygopalatine fossa, about 3 cc. of a 2% procaine solution should be injected slowly.

Area Anesthetized.

With the blocking of the superior maxillary nerve at the pterygopalatine fossa, the entire area of distribution of this nerve will be anesthetized. The anesthesia will last between two and three hours. The symptoms of anesthesia will be numbness of the nose, upper lip and the entire side of the face on which the injection has been made.

Extraoral Mandibular Injection.

The entire mandibular nerve may be anesthetized extraorally, just below its exit from the foramen ovale.

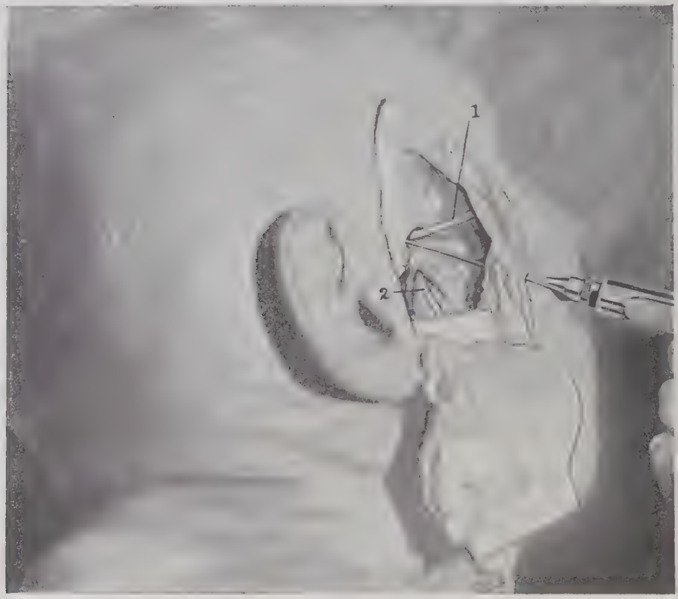


Fig. 143. Extraoral second division injection shown on dissected wet specimen. 1. Superior maxillary nerve. 2. Mandibular nerve.

Landmarks. The sigmoid notch is found on the patient's face and outlined by a pencil or with tincture of iodin. The lower border of the zygomatic arch is also traced on the patient's face. The sigmoid notch may be located as a distinct depression just anteriorly to the condyle and below the zygoma. If possible, the patient should be instructed to open and close his mouth slightly, so that the condyloid process and sigmoid notch may be detected easier. The center of the traced outline represents the point for the needle insertion. (Fig. 144.)

Technique. The area outlined should be thoroughly cleansed and aseptically prepared. Using a 25 mm. 25 gauge needle, a preliminary injection is made in order to establish anesthesia of the skin and subcutaneous tissues. A 60 mm. 21 gauge needle is then used for the final injection. The needle is inserted at the point outlined on the patient's face, at a right angle to the surface of the cheek, and is advanced about 30 mm. Care must be taken not to direct the needle externally or internally, as the needle will then be directed away from the foramen ovale. When 30 mm. of the needle has disappeared in the tissues, it is slightly elevated and about 20 mm. more inserted. At this point the needle will generally strike bone. This will correspond to the smooth under-surface of the greater wing of the sphenoid, just external to the foramen ovale, or the needle may strike the internal wall of the foramen. The distance will vary in different individuals, but the needle should not be inserted more than 50 mm., even though bone may not be encountered. The mandibular nerve will generally be reached at this depth. About

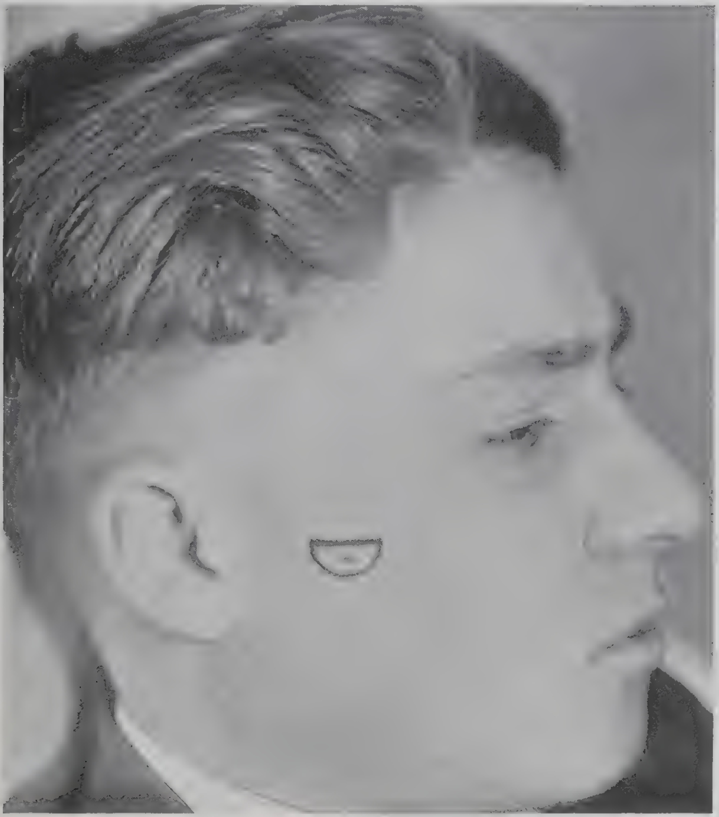


FIG. 144. Landmarks and point of needle insertion in an extraoral mandibular injection.

3 cc. of a 2% procaine solution is slowly injected. Before depositing the solution, a test should be made to determine whether the needle has entered the blood stream. If the solution be deposited at the nerve the patient will experience a momentary sensation of shooting pain, followed by anesthesia. The area anesthetized will correspond to the structures innervated by the mandibular nerve. The anterior or motor root of the third division, which supplies the muscles of mastication with afferent motor filaments, will also be blocked.

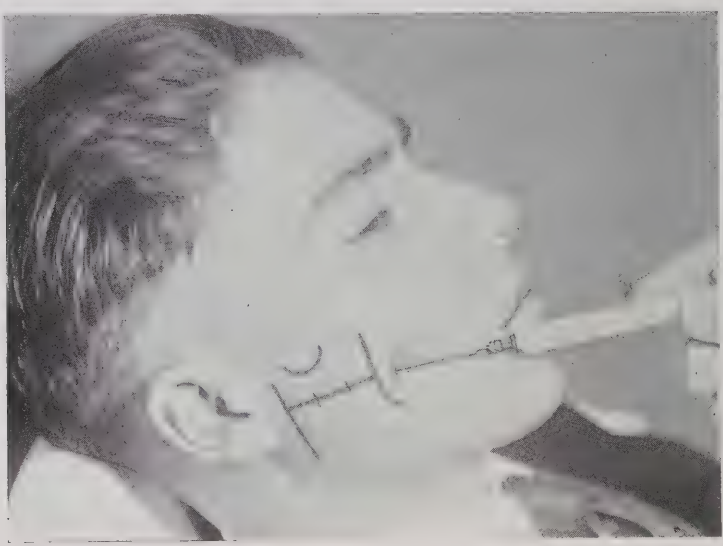


FIG. 145. Landmarks and insertion of needle in an extraoral pterygomandibular injection.

Extraoral Pterygomandibular Injection.

In trismus, fractures of the mandible and many other conditions which preclude an intraoral pterygomandibular injection on account of the patient's inability to open his mouth, the inferior dental and lingual nerves may be anesthetized extraorally. This should be preferred to the blocking of the entire mandibular nerve.

Landmarks. Palpate extraorally the anterior and posterior borders of the ascending ramus and outline these with pencil or iodin on the patient's face. The posterior border of the ramus is easily located. The anterior border may be located by directing, extraorally, the palpating finger superiorly from the external oblique line in the body of the mandible. If possible, have the patient slightly open and close his mouth. This will help to locate the anterior border of the ramus. The sigmoid notch is next outlined on the patient's face. A horizontal line is now drawn, connecting the anterior and posterior borders on a plane of 10 mm. (about ½-inch) above the occlusal surfaces of the lower teeth. When normal alignment and occlusion of teeth have been lost, try to locate the depression extraorally on the anterior border of ascending ramus and draw your horizontal line from this depression. This horizontal line is divided into three equal parts. The dividing point between the second and third thirds represents the location of the mandibular foramen, on the inner side of the ramus. The outline of the sigmoid notch helps the anesthetist to visualize the approximate location of the horizontal line, which should be drawn approximately on a plane of one-third the distance from the sigmoid notch to the lower border of the mandible. (Fig. 145.)

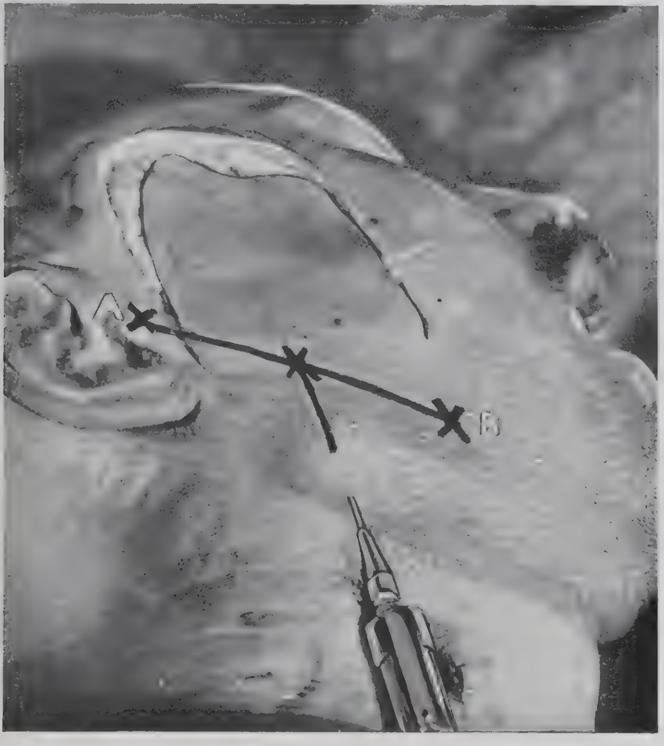


FIG. 146. Extraoral pterygomandibular injection shown on wet specimen. AB. Line drawn from tragus of the ear to the inferio-anterior angle of the masseter muscle.

Technique. A 60 mm. 20 gauge needle should be employed for this injection. The needle should be mounted on an all glass syringe of a narrow diameter, in order to enable the operator to keep the needle in close proximity to the inner surface of the ascending ramus. The anterior two-thirds of the horizontal line are measured, and the distance is indicated on the needle by a disc, or a piece of unvulcanized rubber. A preliminary injection is made to anesthetize the skin and subcutaneous tissues. The 60 mm. needle is then inserted extraorally at the point of junction of the anterior border of the ramus and the horizontal line and directed on the inner side of the ascending ramus, clearing the internal oblique line. The needle is then advanced posteriorly and is inserted the length measured off on the needle, representing two-thirds the distance between the anterior and posterior border of the ramus. The

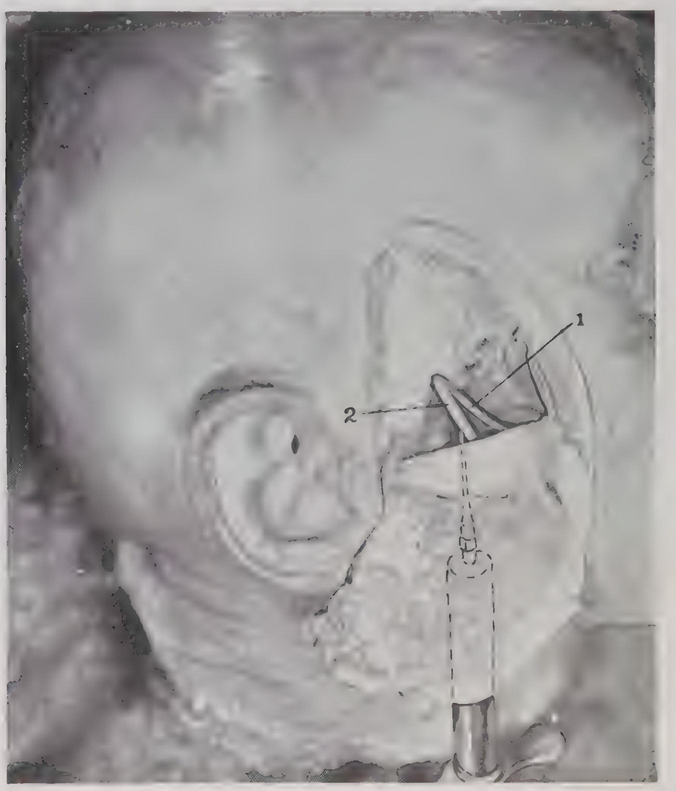


Fig. 147. Needle in final position in an extraoral pterygomandibular injection, shown on wet specimen. The infratemporal region is here exposed. 1. Lingual nerve. 2. Inferior dental nerve.

unmounted needle should be inserted in order to enable it to be directed as near the ascending ramus as possible. Having placed the needle in position, it is then connected to the syringe and about 3 cc. of a 2% procaine solution is slowly injected into the mandibular sulcus. The divergence of the ascending ramus makes it impossible to strike the mandibular sulcus with the point of the needle, but the two-thirds distance will assure the discharge of the solution sufficiently near the inferior dental nerve to obtain anesthesia by diffusion. The needle should be directed on a plane with the horizontal line previously drawn on the patient's cheek.

If there is no infection and swelling around the anterior border of the ascending ramus, this injection may be made within the vestibule of the mouth, even when the patient cannot open his mouth. The needle is inserted so as to clear the internal oblique line to a depth of two-thirds of the distance of the width of the ramus.

Area Anesthetized.

The area anesthetized by this injection will correspond to the area blocked by an intraoral pterygomandibular injection. The inferior dental, lingual and frequently the long buccal nerves will be anesthetized. With anesthesia established, the mouth is forced open, and the offending tooth removed, or the necessary operation performed.

Another Method.

Another method of making an extraoral pterygomandibular injection is described by Dr. Kurt H. Thoma, and is a modification of the Kantrowicz technique:

A line is drawn from the tragus of the patient's ear to the inferioanterior angle of the masseter muscle. This line is equally divided; the point of division will represent the position of the mandibular sulcus on the inner surface of the ascending ramus. A line is then drawn from this point downward to the inferior border of the ramus and parallel with its posterior border. The length of this line will represent the distance which the needle must travel to reach the mandibular sulcus. The length is then designated on a 60 mm. needle by a disc or a piece of unvulcanized rubber. The patient's head is placed on one side as far as possible. The site of the injection is properly prepared. The needle is inserted beneath the lower border of the ascending ramus and directed upward along its inner surface parallel with the posterior border of the ascending ramus and according to the vertical line on the face. The needle is inserted the length previously ascertained and the solution slowly discharged. An attempt should be made to keep the needle as close to the inner surface of the ramus as possible. The needle will pass through the insertion of the internal pterygoid muscle and will be in the pterygomandibular space when the injection is made. (Figs. 146 and 147.)

CHAPTER VII.

INFILTRATION ANESTHESIA.

Many operators will make a distinction between local and conduction anesthesia, confusing local anesthesia with the infiltration method. As a matter of fact conduction anesthesia is a subdivision of local anesthesia.

Local anesthesia may be defined as a method of depriving a certain area of sensation without interference with the brain centers, and therefore without loss of consciousness. Many methods of producing local anesthesia have been tried in the past, such as freezing, pressure, etc. These met with little, if any, success until the aqueous solution of certain organic chemical compounds such as cocain, stovain, procaine, etc., were introduced and injected into the tissues by means of a hypodermic syringe.

Subdivisions of Local Anesthesia.

Local anesthesia may be subdivided into four main classes.

1. Infiltration, peripheral or terminal. 2. Conduction or nerve blocking. 3. Intraärterial. 4. Intravenous.

By the infiltration method we endeavor to anesthetize the peripheral or terminal nerve filaments of a certain area by injecting the anesthetic solution into or around that area; hence this method is also called the peripheral or terminal.

By the nerve blocking method, or conduction anesthesia, the nerve trunk is blocked at some point between the periphery and the brain, thereby depriving of sensation the area supplied by that nerve, distally to the point where the nerve was blocked. Conduction is perhaps not a very good term by which to designate this method of producing anesthesia. The term "nerve blocking" more fully describes it. In dental injections the anesthetic solution is seldom, if ever, deposited directly into the nerve trunk. The solution is generally injected some distance away from the nerve, but is diffused or "conducted" to its final destination until the nerve is reached and anesthetized. Hence the term "conduction anesthesia."

Injection of the anesthetic into an artery will produce anesthesia of the area supplied by that particular artery. This is intraärterial anesthesia.

In a similar manner anesthesia has been obtained in an area by injecting the anesthetic solution into a vein draining that area. This is termed intravenous anesthesia.

We shall take up singly these various methods of producing local anesthesia.

The Infiltration Method.

While conduction anesthesia is making great strides and steadily gaining converts, the infiltration method will always remain the most favored by the profession; and justly so, for if a patient should present himself for the extraction of a single tooth or root, without any inflammation or infection, the infiltration method would always be indicated, more especially on the maxilla. Infiltration anesthesia may be employed not only for the extraction of teeth, but for extirpation of pulps, grinding of teeth, preparation of cavities and for almost any dental operation. It should be borne in mind that the same care in asepsis, preparation of the solution, etc., must be exercised in infiltration anesthesia as in nerve blocking injections.

How Infiltration Anesthesia Is Produced.

Several physical and perhaps physiological factors enter into the anesthetization of tissues by infiltration. When soft tissues are infiltrated, the anesthetic solution will diffuse through these tissues reaching the nerve endings and combining with the protoplasm of the nerve cells. When bony structures are concerned, such as the alveoli of the teeth, the anesthetic solution will reach the pulp chamber by permeating through the periosteum, then the alveolus, and finally finding its way to the apical foramen and into the pulp chamber. Here diffusion, absorption, capillary attraction, surface tension and perhaps some unexplained physiological action take place. It is a noteworthy fact that the richer the bony structures are with small foramina, the better and quicker anesthesia will be produced. On the other hand the absence of these perforations will retard absorption and often fail to produce the desired result altogether.

Structure of the Maxillæ.

In examining the superior maxillary bones, numerous small openings will be observed, especially over the alveolar plates; lingually more so than facially. These foramina are more numerous around the anterior teeth than around the bicuspids and molars. The canine and incisive fossæ present many of these perforations. (Fig. 148.)

The tuberosity of the maxilla around the posterior superior alveolar foramen presents a regular sieve-like appearance.

The lingual alveolar plate of the upper teeth, and, as a matter of fact,

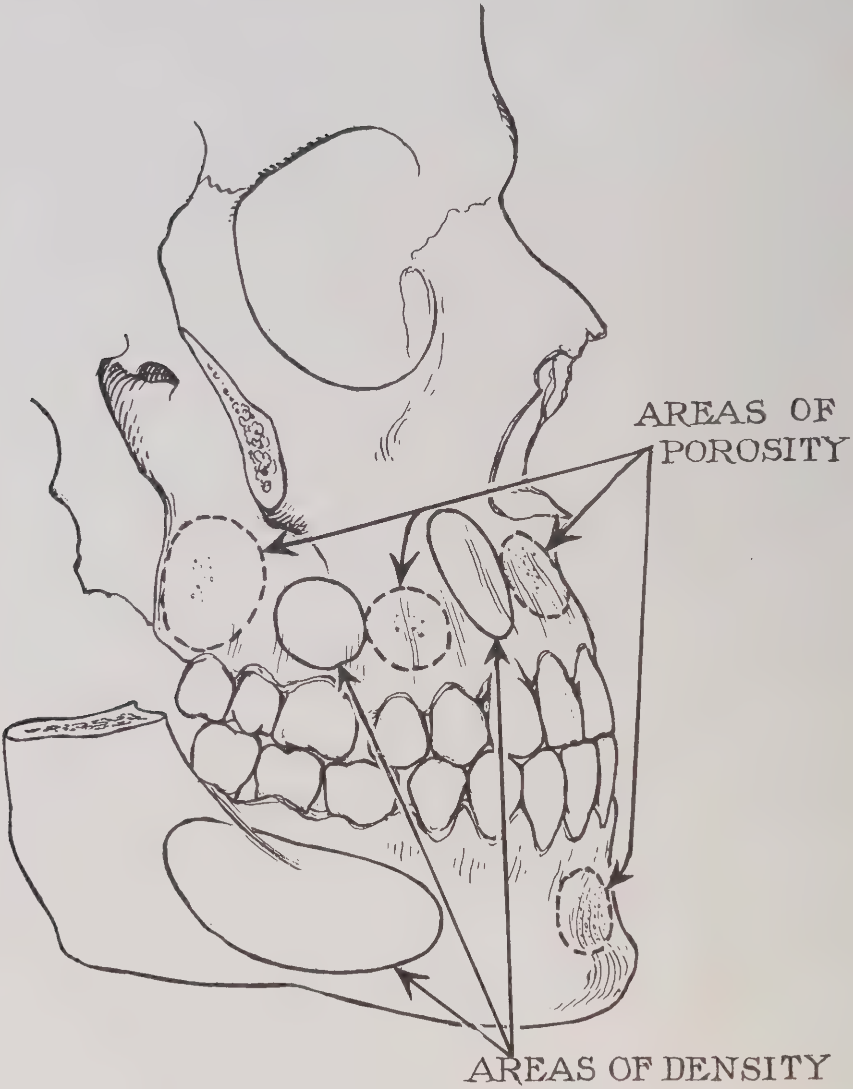

AREAS OF POROSITY
AREAS OF DENSITY

FIG. 148. Drawing of mandible and superior maxilla showing areas of density and porosity.

the entire palate process, present numerous foramina, and absorption of the solution in this region is very rapid. (Fig. 149.)

Structure of the Mandible.

The structure of the mandible is somewhat different from that of the superior maxilla. The alveolar processes of either the maxilla or the mandible consist of a dense outer cortical layer made up of compact bone, which covers an inner spongy or cancellous structure. The outer, or cortical layer of the mandible is much denser and thicker than that of the maxilla and the spongy substance is richer in ramifications and size of the lacunæ and canaliculi are larger in comparison with the maxilla. The thick outer cortical layer of the mandible has comparatively few foramina through which the solution can travel to the inner cancellous compartment. They are most numerous on the facial alveolar plate of the lower anterior teeth, particularly in the mental or incisive fossæ. Small foramina can be found also at the symphysis facially and the genial tubercles lingually. The alveolar plate of the lower bicuspids has few foramina both buccally as well as lingually, while around the molar teeth the alveoli are unusually thick and dense, rendering the absorption of the solution very difficult. (Figs. 148 and 151.)

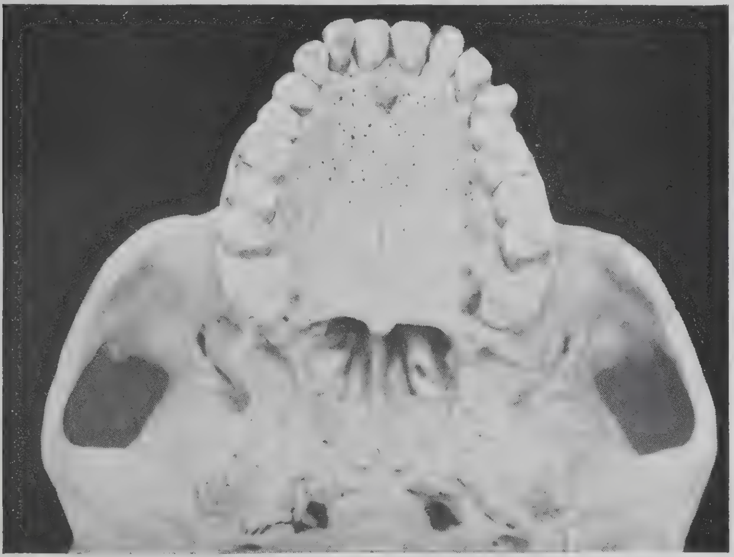


Fig. 149. Numerous foramina shown on the palate.

Method of Penetration. The anesthetic solution, when injected around the tooth to be operated on, by virtue of certain physical and physiological laws, will penetrate through the outer dense cortical plate; find its way to the inner cancellous substance; diffuse through the Haversian system and finally penetrate into the alveolus. At this stage the peridental membrane, the peridental lamella and the alveolus will be sufficiently anesthetized to enable the painless removal of the tooth. Later, the solution will diffuse through the apical foramen into the pulp chamber, chemically combining with the nerve tissues of the pulp and thus completely anesthetizing it, so that not only may any operation be painlessly performed on the tooth, such as grinding, preparing the cavity, etc.; but the pulp itself may be painlessly extirpated.

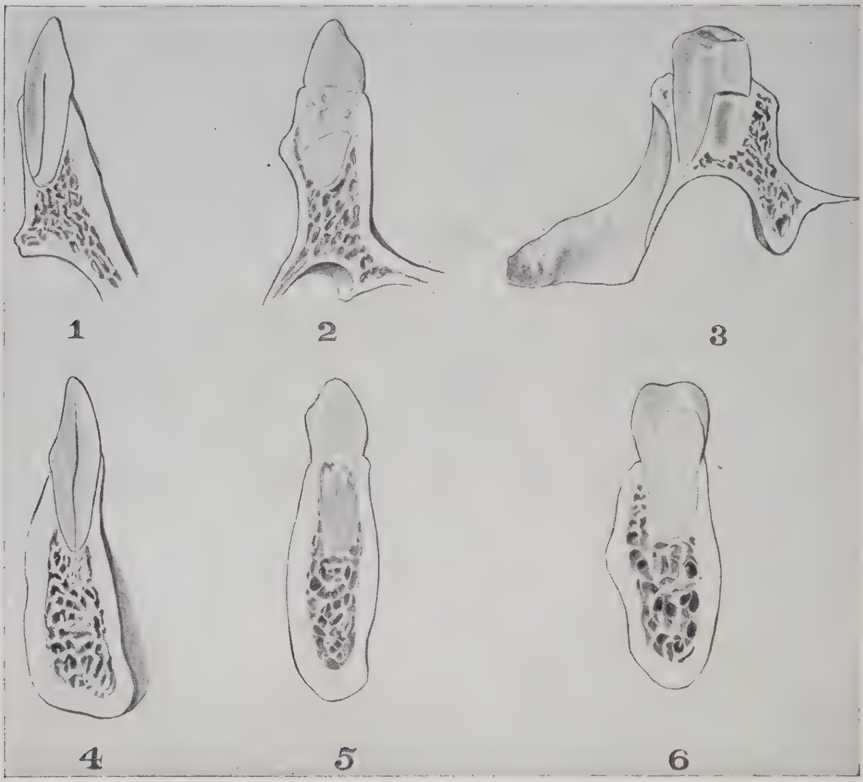


FIG. 150. Cross sections showing the cortical and cancellous structure of the mandible and maxilla. 1. Upper central. 2. Upper bicuspid. 3. Upper molar. 4. Lower central. 5. Lower bicuspid. 6. Lower molar.

Fig. 152 represents a labiolingual longitudinal section of an upper anterior tooth. All the structures from the mucous membrane to the pulp of the tooth are exposed to view. The solution injected either beneath the mucous membrane or the periosteum F, will find its way through the cortical layer D, reach the cancellous structures C, travelling by osmosis and diffusion through the lacunæ and canaliculi, finally reaching the peridental membrane E. Thus the alveolus is anesthetized. The solution will then either penetrate the cementum or, through the apical foramen, reach the pulp chamber. Most likely, however, it is taken up by the blood vessels which run in three different directions; at right angles to the tooth G, parallel to its long axis B, or entering the foramen as shown at B. All the blood vessels combine to enter the pulp chamber at the apical foramen together with the nerves A, and to form, together with some connective tissues, the pulp proper. Anesthesia of the pulp is produced by blocking the nerve supply at A and also by anesthetizing the terminal nerve endings and Tomes' fibers, which give sensation to the dentin. It must be remembered that although the nerve supply of the pulp is mainly at A, yet it is reasonable to suppose that the nerves supplying the peridental membrane may also carry sensation to the pulp. In this illustration the lingual mucous membrane, periosteum and alveolar plate are supplied by a branch of the nasopalatine nerve, while the pulp tissue is supplied by a branch of the anterior superior alveolar nerve.

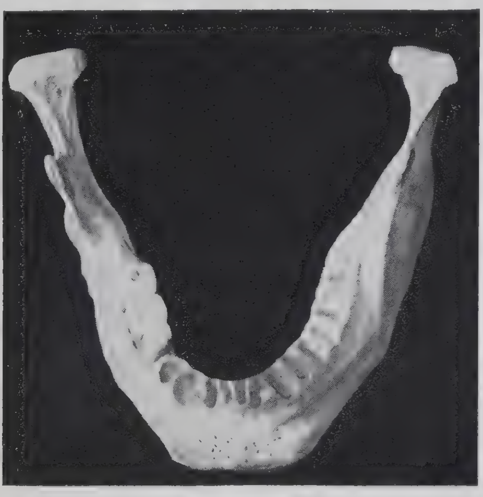


FIG. 151. Perforations at the mental fossæ. Note the thick and dense bone at the bicuspids and molars.

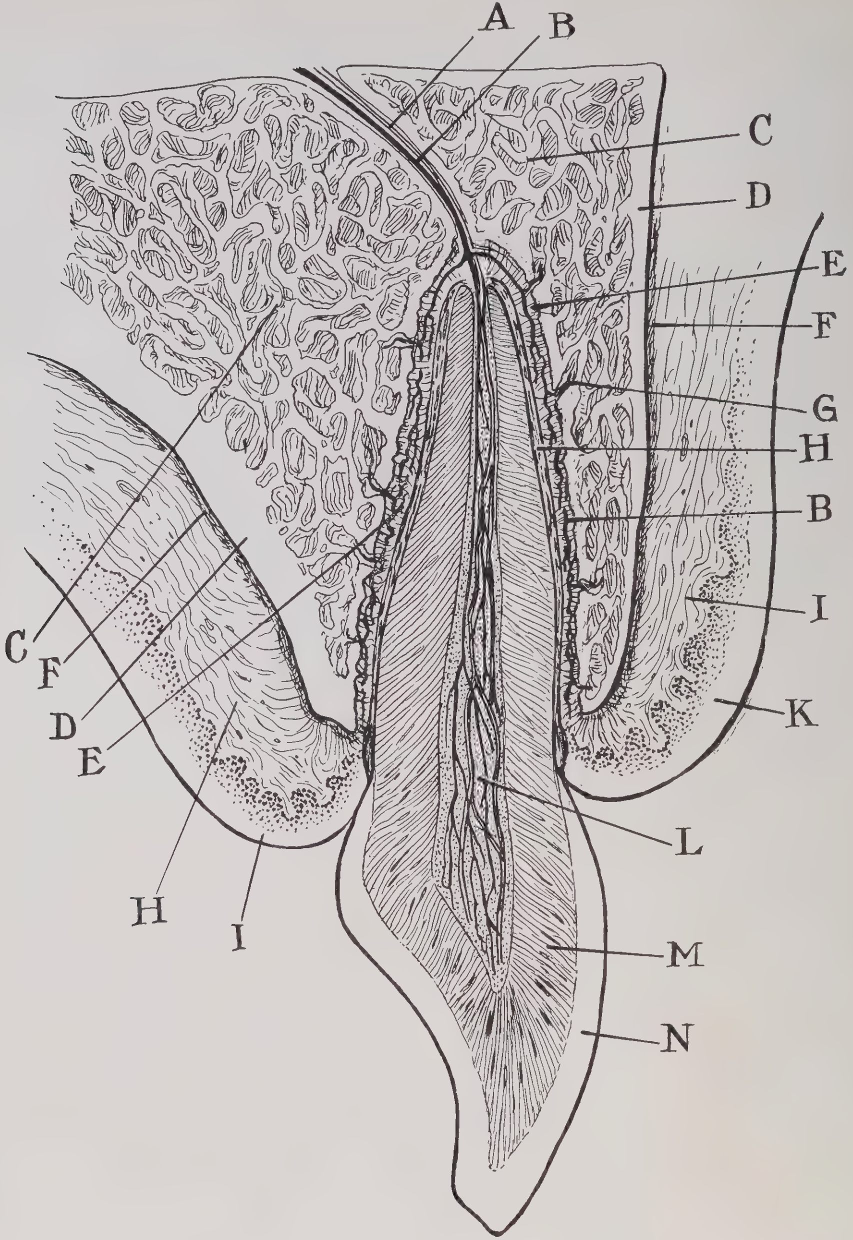


FIG. 152. Longitudinal labiolingual section of an upper anterior tooth showing all the investing tissues. A. Nerve supplying pulp. B. Blood vessel entering apical foramen. C. Cancellous structures of alveolar plate. D. Cortical outer layer. E. Peridental membrane. F. Pericementum. G. Blood vessels entering peridental membrane at right angle. H. Cementum. I. Submucous tissue. K. Mucous membrane. L. Pulp tissue. M. Dentin. N. Enamel.

Therefore it is advisable, for the purposes of nerve extirpation, grinding, preparation of cavities, etc., to make a lingual as well as a labial injection.

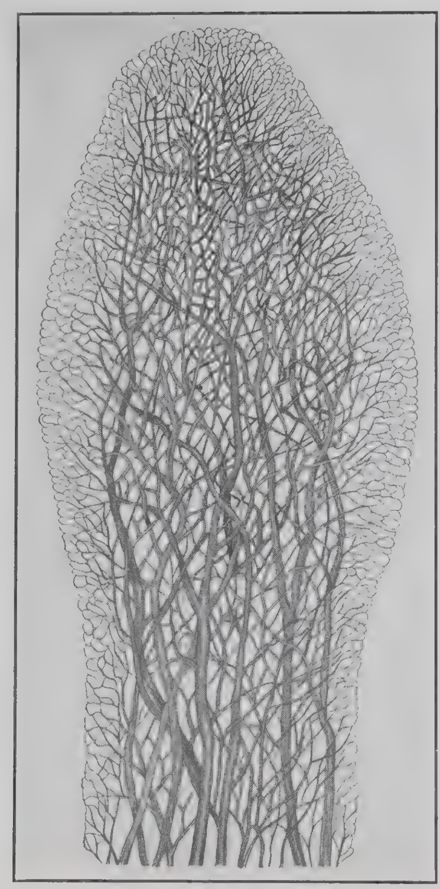


FIG. 153. Ramification of the blood vessels in the dental pulp. (C. H. Stowell.)

Fig. 153 shows the blood supply of the pulp and the ramification of the blood vessels. The anesthetic solution travels by this vascular route, completely anesthetizing every particle of the highly sensitive organ.

Methods of Producing Infiltration Anesthesia.

Anesthesia by infiltration may be produced by the following methods:

1. Submucous, when the solution is injected beneath the mucous membrane.
2. Subperiosteal, when the solution is injected beneath the periosteum.

3. Peridental, when the solution is injected into the peridental membrane.

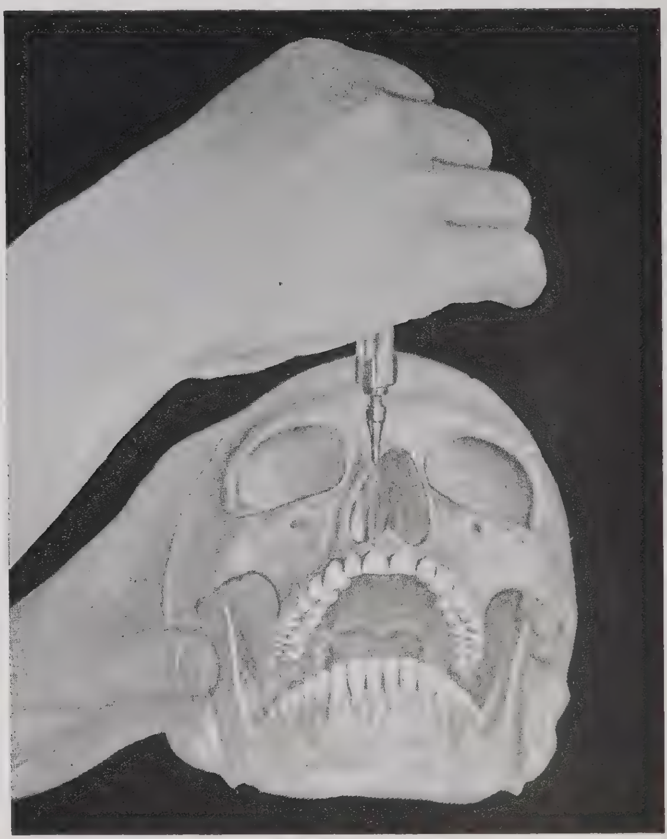


FIG. 154. Infiltration anesthesia, subperiosteal method. Insertion of needle shown on skull.

4. Intraseptal, when the solution is injected into the interdental septum.
5. Intraosseous, when the solution, after perforating the outer alveolar plate, is injected into the cancellous structure of bone.

Submucous Method.

When the anesthetic solution is injected beneath the mucous membrane, a wheal will frequently be formed. Submucous anesthesia is indicated in places where there are no bony structures to contend with, or in blocking the long buccal nerve in the buccinator muscle or when injecting the solution submucously over the teeth to be removed. Submucous injections are also used in cases where it is necessary to anesthetize the mucous membrane only, or where it is not possible to inject the solution beneath the periosteum. The wheal is caused by the solution being slowly absorbed. The absorption may be hastened by massaging the wheal with the fingers. The submucous method of producing infiltration anesthesia is not indicated when absorption through bony structure is essential in order to produce the desired results, such as in the extraction of teeth. The solution, in order to reach the alveolus, must of necessity travel through the peridental membrane and then through the alveolar plate.

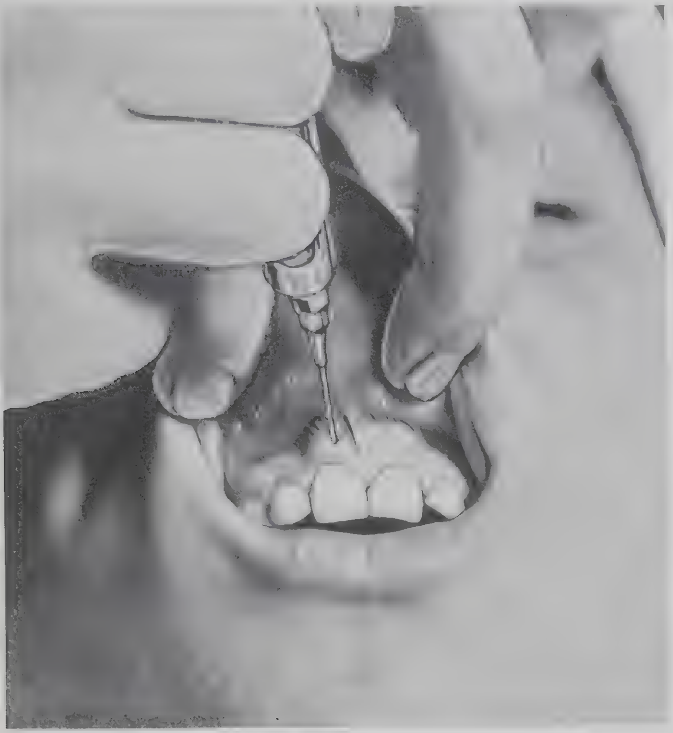


FIG. 155. Infiltration anesthesia, subperiosteal method, shown on patient. Insertion of needle at right angles to the mucous membrane.

Subperiosteal Method.

In submucous injections there will be a tendency for the solution to be carried away from the point of injection by the lymphatics, so that a larger volume of the solution is necessary to obtain proper anesthesia. When injected beneath the periosteum, the solution is confined by it to the alveolar plate. Absorption and surface tension is thus facilitated and less of the anesthetic solution is required.

Needle Employed.

A 25 mm. 23 gauge needle of steel or iridio-platinum may be employed for the subperiosteal injection. The needle should be mounted on a screw hub syringe, as considerable pressure is required for this injection. A slip-on needle may be forced off the hub during the injection.

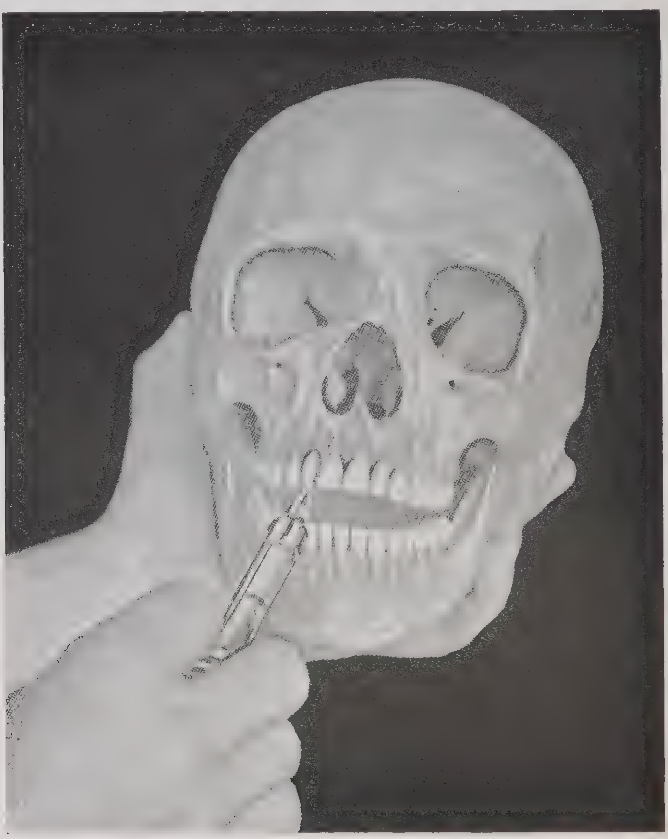


FIG. 156. Subperiosteal injection shown on skull. Final position of needle, injecting the solution at the apex of the tooth.

Technique for Subperiosteal Method.

Let us suppose we want to anesthetize an upper central tooth subperiosteally, by infiltration. The gum tissue above the tooth facially and lingually is sterilized with tincture of iodin. A sterile syringe, filled with a previously properly prepared solution, with a mounted sterile needle, is picked up in a pencil-like manner and the needle inserted into the gum tissues midway between the gingiva and the approximate position of the apex of the tooth. The needle is inserted at right angles to the alveolar plate. Slight force is used in order to penetrate the periosteum. (Figs. 154 and 155.) A few drops of the anesthetic solution are deposited here. The needle is then placed parallel to the alveolar plate and forced beneath the periosteum toward the apex of the tooth, the bevel of the needle toward the bone. A few drops of the solution should be discharged as the needle progresses. When the apex is reached, about two-thirds of a 2 cc. syringeful is slowly injected. (Figs. 156 and 157.) The solution, by penetrating the alveolar plate at the tooth, will find its way through the apical foramen and into the pulp chamber, thus anesthetizing not only the alveolus but also the pulp tissue as well. The remaining one-third of the solution is deposited lingually in a similar manner, namely, beginning midway between the gum margin and the apex of the tooth and proceeding toward the apex where the solution is deposited. Less

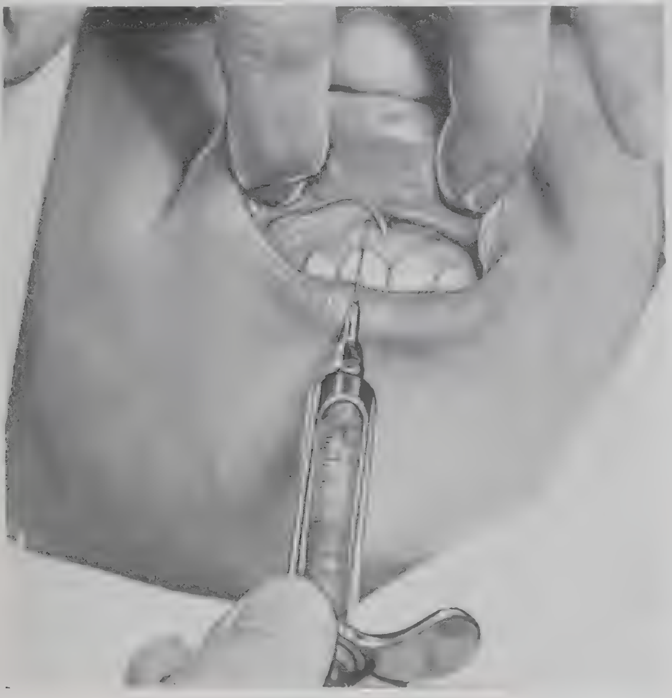


FIG. 157. Final position of needle in a subperiosteal infiltration injection shown on patient.

of the solution is used lingually than facially on account of the dense facial plate and the numerous foramina palatally, which greatly facilitate absorption. (Fig. 158.)

In Exodontia. The alveolar plate will be anesthetized sufficiently to enable the painless removal of the tooth in one or two minutes after the injection.

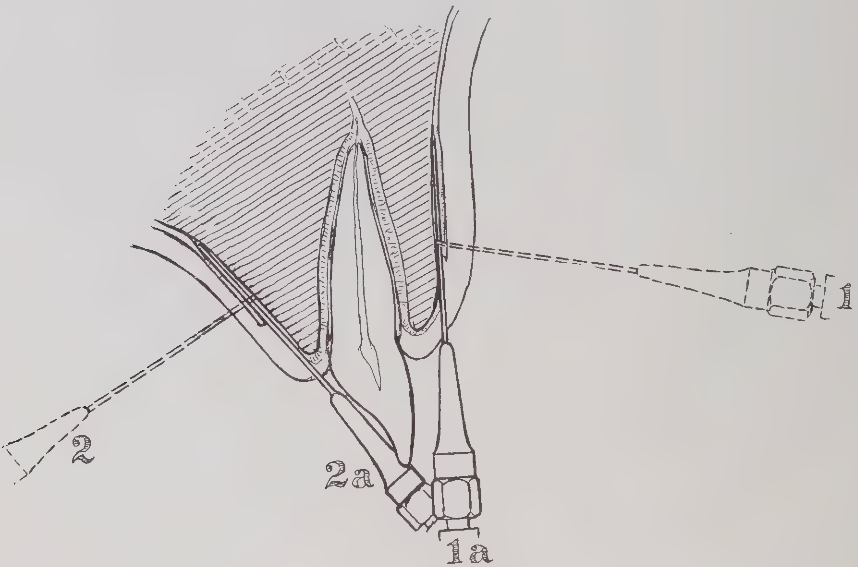


FIG. 158. Subperiosteal infiltration anesthesia shown on diagram. 1 and 1a show the insertion and final position of the needle labially. 2 and 2a show the same lingually.

In Pulpectomy. Should we desire to remove the pulp, grind the tooth, prepare a cavity, etc., five or, still better, ten minutes should elapse after the injection before the operation is undertaken. This intervening time will give the anesthetic an opportunity to permeate not only through the alveolus but also into the pulp chamber, thus effectively anesthetizing the pulps. The time necessary to produce complete anesthesia may be utilized by the operator to make all the necessary preparations, such as adjusting the rubber dam, sterilizing the necessary instruments, etc. By the time all these preparations are completed, the tooth will generally be sufficiently anesthetized to enable the operator to drill into the pulp chamber and remove the pulp painlessly and more or less bloodlessly, due to the vasoconstrictor action of the supranol incorporated in the procaine tablets used.

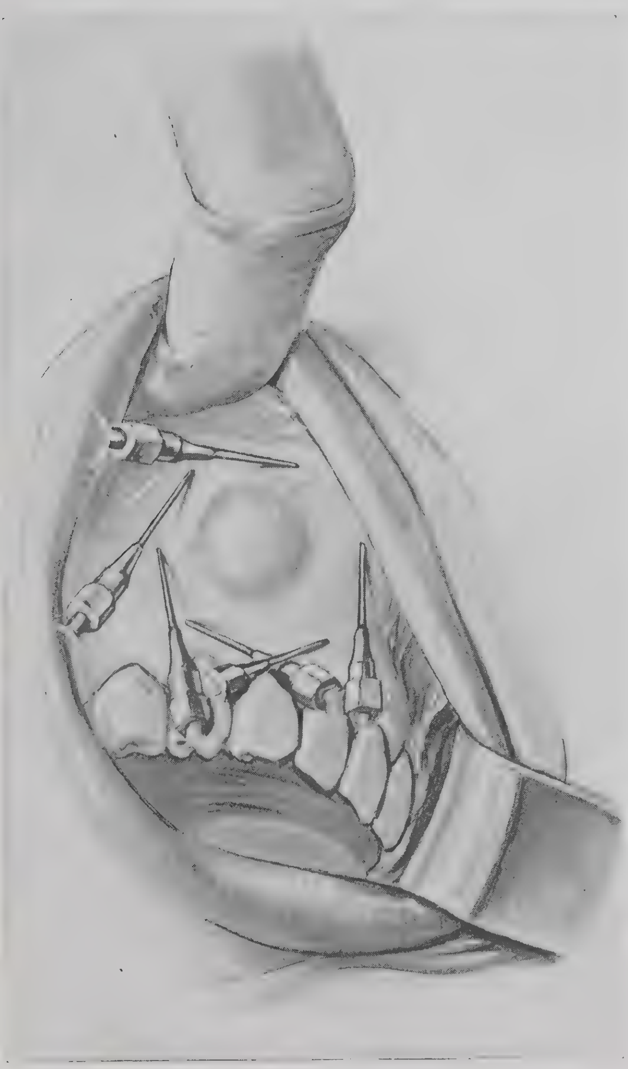


FIG. 159. Infiltration injections around infected area.

The subperiosteal method of anesthetization is most ideal in cases where the pulp has undergone partial calcification, in pulp stones, and in cases of pathological involvement of the pulp. In such cases the pulp will resist devitalization by arsenic and anesthetization by pressure anesthesia also. The difficulty of removing a small vital fragment of the pulp left after pulpectomy is well known to many practitioners. Even several applications of arsenic trioxid will not avail and may result in severe pericemental inflammation; nor will pressure anesthesia bring about the desired results. The only sure and effective method of completely anesthetizing and removing remaining vital nerve fibrils is by means of a subperiosteal injection, properly performed.

There is very little danger, if any, of strangulation and death of the dental pulp due to subperiosteal injections. Sometimes there may be soreness following the injection and the operation on the tooth. This, however, generally subsides in a day or two. This condition may be due to slight inflammation of the peridental membrane or else to the periapical disturbances following the complete removal of the pulp.

Needle Employed.

A very short needle should not be used in a subperiosteal injection. The needle should be about 25 mm. long and under no circumstances less than 20 mm.; for about 10 or 12 mm. is generally required to reach the apex of the tooth. Besides, the short needle has not the resiliency so necessary to enable the operator to follow the alveolus beneath the periosteum. A short needle may also break off at the hub and disappear in the soft tissues.

When Effective and When Delayed.

The effectiveness of subperiosteal anesthesia will depend entirely upon the thickness and density of the alveolar plate and particularly its cortical layers. This varies in different parts of the alveolar processes. It is thinner in the superior maxilla than in the mandible. For this reason subperiosteal anesthesia is effective in the superior maxilla, especially so in the regions of the anterior and bicuspid teeth. In the upper molar teeth, absorption generally takes a little longer. In the lower anterior teeth, absorption is fairly rapid, while in the lower bicuspids and especially molars, absorption is delayed and sometimes entirely prevented by the unusual thickness and density of the alveolar plate in that region. (Fig. 97.) The character of the alveoli varies not only in different parts of the maxilla and the mandible but also in different individuals. This will account for the failures encountered in infiltration anesthesia where the alveolar plate is thick. In such cases nerve blocking injections should always be used.

It is a noteworthy fact that the younger the patient the more effective will be the submucous and subperiosteal injections. On the other hand, the older the patient, the slower will be the absorption of the anesthetic solution and therefore the less effective it will be. This is due to gradual condensation of bone as the patient advances in life. Then again, as the patient grows older and there is a condensation and subsequent contraction of bony structures, the various foramina become larger, so that nerve blocking injections are more effective in older people than in young subjects.

In the upper second and third molar teeth, when producing anesthesia by the subperiosteal method, it is difficult to direct the needle parallel with long axes of these teeth. The needle in such cases may be directed parallel with the occlusal surfaces of the teeth, inserting it beneath the periosteum in line with their apices.

Disadvantages of Infiltration Anesthesia.

The main disadvantage of infiltration anesthesia, either by the submucous or the subperiosteal methods, is that a great many punctures must be made if a number of teeth are to be anesthetized. Also, a considerable quantity of the anesthetic solution must be injected. In infected areas, infiltration should be strongly condemned, as the injection of the solution may carry the infected material into the deeper strata and thus cause osteomyelitis and necrosis. It is possible, however, in cases of infection, to circumscribe the injection of the solution around the infected area, being careful not to invade the inflamed tissues. This may be looked upon as a method of nerve blocking, inasmuch as we endeavor to block the larger nerve filaments before their ramification to supply the infected area. (Fig. 159.)

Infiltration Anesthesia in a Number of Teeth in the Superior Maxilla.

To obviate the necessity of a great many punctures in anesthetizing a number of contiguous teeth in the maxilla, the following method may be employed to good advantage:

Let us suppose that we wish to anesthetize the upper anterior teeth, the bicuspids and perhaps the molars.

Syringe and Needle Employed.

A 3 cc. or 4 cc. syringe should preferably be used for this injection. The needle should be at least 42 mm. long, 23 gauge, of either iridio-platinum or steel.

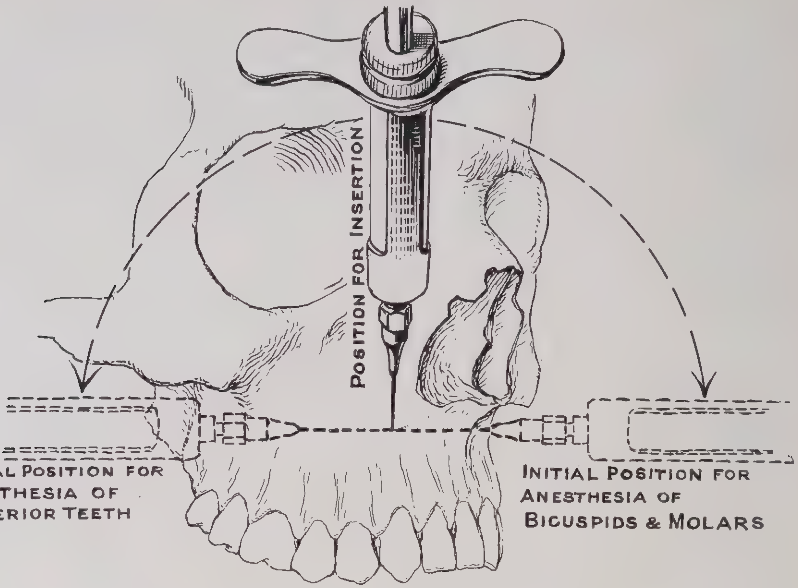

POSITION FOR INSERTION
INITIAL POSITION FOR ANESTHESIA OF ANTERIOR TEETH
INITIAL POSITION FOR ANESTHESIA OF BICUSPIDS & MOLARS

FIG. 160. Diagram showing the anesthetization of the upper teeth infiltratively by one puncture of the needle at the apex of the cuspid tooth.

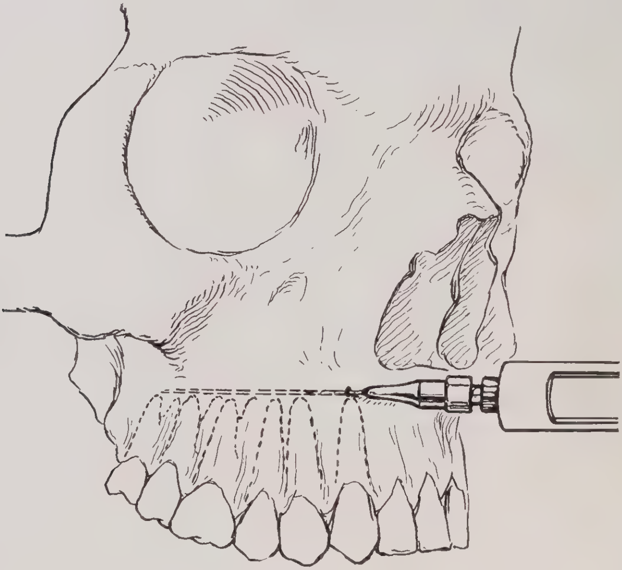


FIG. 161. Infiltration anesthesia for the upper bicuspids and molars.

Technique. The point of insertion should be the apex area of the cuspid tooth. The gum is rendered surgically clean. The needle is inserted beneath the periosteum at the apex of the cuspid tooth and about 1 cc. of the anesthetic solution is deposited. The needle is then placed parallel to the occlusal surfaces of the teeth, with the bevel toward bone and directed posteriorly, endeavoring to keep it beneath the periosteum. This, however, is not always an easy task on account of the concave canine fossa. When the apices of the first bicuspids are reached another 1 cc. of the solution is deposited. The second bicuspid and the molars are anesthetized in the same manner. (Figs. 160 and 161.) If the anterior teeth also are to be anesthetized, the needle is brought back to the original point of insertion but not withdrawn and is then directed over the root apices of the lateral and central teeth and the anesthetizing solution injected at the apices of each tooth. (Figs. 160 and 162.) If necessary, the syringe may be refilled and the needle again inserted at the point of the previous puncture. In this manner the entire outer alveolar plate, the peridental membrane and the pulps of the teeth may be anesthetized. For the purposes of extraction, however, the lingual alveolar

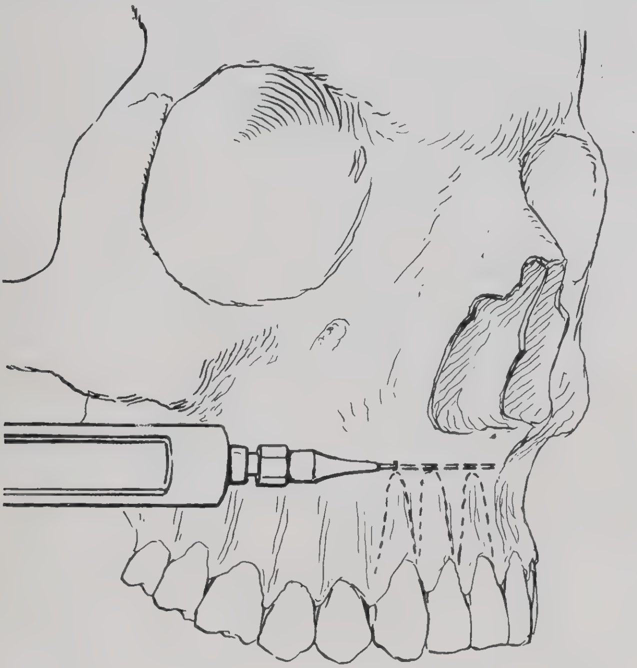


Fig. 162. Infiltration anesthesia for the upper anterior teeth.

plate and its soft coverings must be anesthetized separately. In order to avoid the injection of an excessive amount of the anesthetizing solution and repeated punctures of the mucosa, the posterior palatine and incisive injections should be made instead of injecting infiltratively over each tooth separately. In this manner nearly all the upper teeth may be anesthetized without resorting to the infraorbital or tuberosity injections. This method of anesthetizing a large area in the maxilla is a distinct advantage over injecting around each tooth separately, in that repeated punctures of the mucosa and therefore additional chances for infection and trauma are avoided, and also because less of the anesthetic solution is required. However, in such instances, the writer prefers an infraorbital injection supplemented, if necessary, by a tuberosity injection. It is simpler, less of the solution is required and the results are more positive.

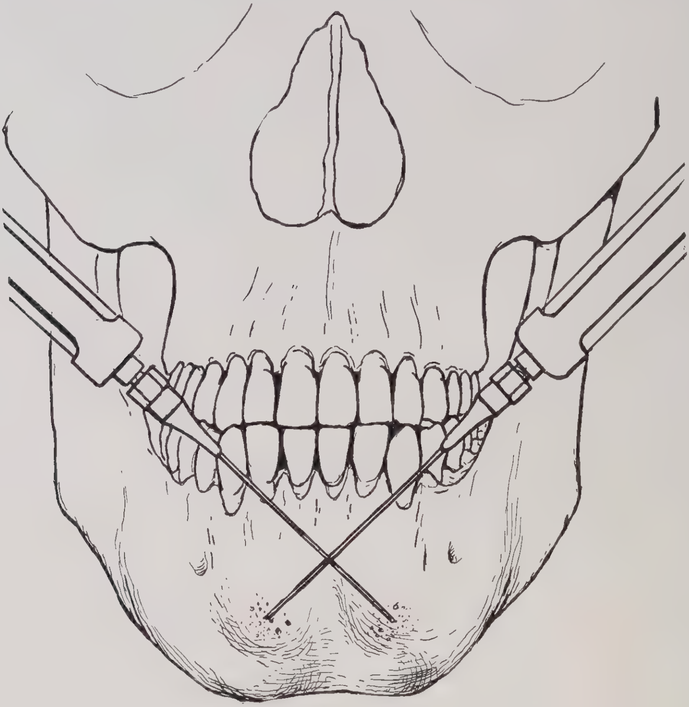


Fig. 163. Infiltration anesthesia of the six anterior lower teeth.

Infiltration Anesthesia in the Six Lower Anterior Teeth.

The six lower anterior teeth may be anesthetized by depositing the solution into the incisive fossæ. It will be remembered that these fossæ are located below and between the apices of the lateral and cuspid teeth. The floor of the incisive fossa abounds with foramina, which ramify through the external cortical plate of the mandible and connect with the spongy substance internally. The anesthetic solution therefore, when deposited into this fossa, will readily infiltrate through to cancellous structure and anesthetize the incisive nerve, thus anesthetizing the lower anterior teeth.

Technique. A 25 mm. 23 gauge needle may be used for this injection. Standing on the right side of the patient or slightly behind, the left hand is thrown around the patient's head. The lip is retracted with the thumb and the index finger. The needle is now inserted at the median line and into the reflection of the mucous membrane, as low as possible. At first the left incisive fossa is sought, directing the needle at an angle of about 45° between the syringe and the occlusal plane of the incisive teeth. (Fig. 132.) The fossa will be found at a distance of about 15 mm. Sometimes the floor of the fossa may be encountered by the point of the needle. 1 cc. of a 2% procain solution is slowly injected. The needle is withdrawn to the original point of insertion but not removed from the tissues and is directed toward the right incisive fossa, maintaining the same 45° angle. When the right incisive fossa is located, another 1 cc. solution is injected. The bevel of the needle is directed toward bone, endeavoring to keep it beneath the periosteum as much as possible. When the injections are completed the gums are gently massaged with the index finger, to force the solution through the small appertures of the incisive fossæ into the cancellous structure and incisive canal. (Fig. 163.)

Lingual Anesthesia. It must be remembered that the lingual mucous membrane is supplied by the lingual nerve and therefore, in cases of extraction or any operation which would involve the lingual mucous membrane, separate injections must be made lingually to complete the anesthesia. This is accomplished by making two subperiosteal injections lingual to the central incisors, by depositing about 10 drops in each side. This is done to anesthetize the terminal filaments of the lingual nerve and to assist absorption through the small foramina on either side of the genial tubercles. (Fig. 11.) Two more subperiosteal injections are made, lingually of the cuspid teeth, one on either side, depositing about 10 drops in each injection. This is done to block the branches of the lingual nerve on their way to innervate the lingual mucous membrane of the six anterior teeth.

Area Anesthetized. With the two incisive fossæ injections satisfactory anesthesia may be obtained in the lower incisor teeth and very frequently in the six anterior teeth. Whenever it is desired to anesthetize this area, however, the writer prefers to make two mandibular injections, one on each side. The results are more certain, the procedure simpler and less solution is required to obtain the desired results.

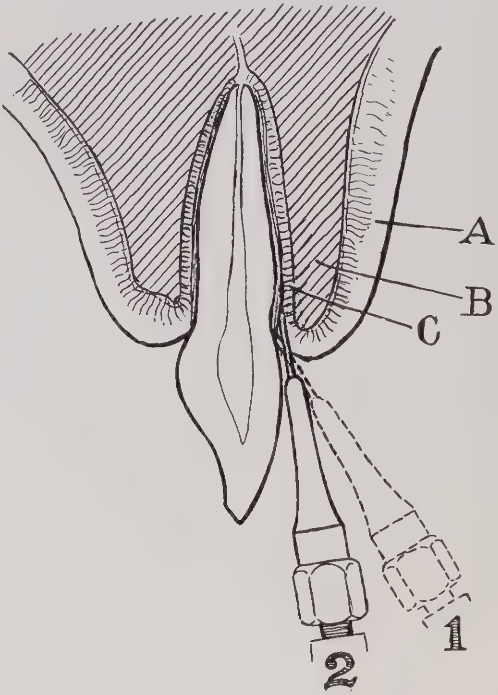


Fig. 164. Diagram showing peridental injection in a buccolingual section. A. Mucous membrane. B. Outer alveolar plate. C. Peridental membrane. 1—Insertion of needle. 2—Needle between peridental membrane and cementum of the tooth.

Peridental Anesthesia.

By the peridental method of producing anesthesia, the solution is injected directly into the peridental membrane, beneath the free margin of the gum. This method has been particularly recommended by Dr. Herman Prinz. The solution, when injected, will be quickly carried by the blood vessels of the peridental membrane, through the periapical foramen and into the pulp chamber, thus anesthetizing not only the alveolus for the removal of the tooth but also the pulp itself for painless pulpectomy, pulpotomy, preparation of cavities, grinding, etc.

Needle and Syringe Employed. A short needle, with a sharp point, should be used for this injection. It should not exceed 10 mm. (about ⅜ inch) in length and 23 gauge in thickness. An all metal syringe is indicated, one which will withstand a great deal of pressure without regurgitation.

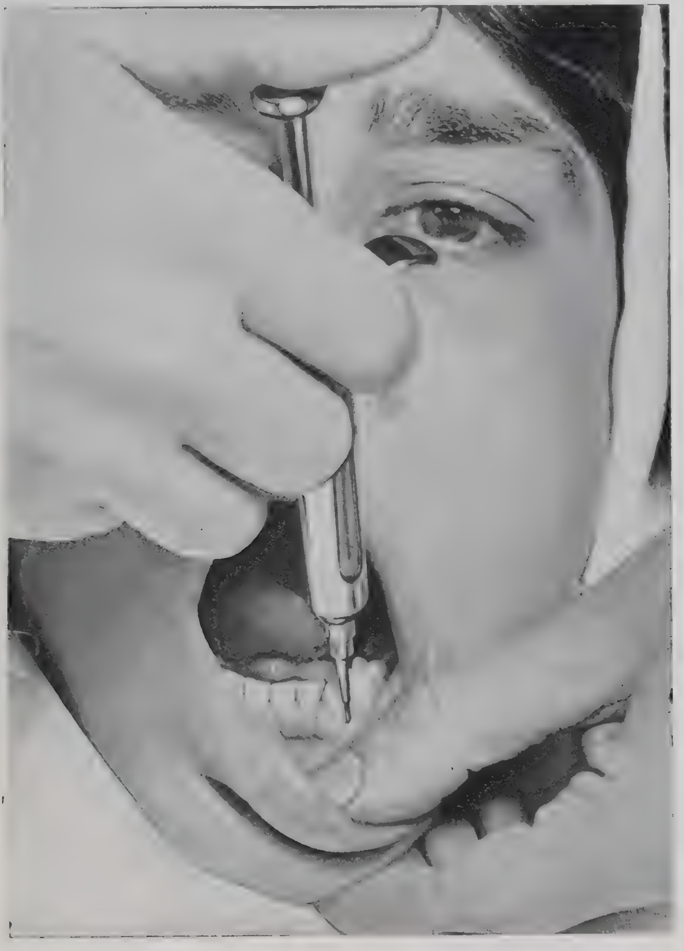


FIG. 165. Peridental injection shown on patient.

Technique. The gum margin around the tooth is painted with tincture of iodin or still better with a mixture of one part of iodin and two parts of acetone, as suggested by Dr. Prinz. It is imperative to take thorough anteseptic measures to avoid the possibility of forcing the food debris and infected matter around the circular ligament into the deeper strata.

The needle is inserted on the mesial side of the tooth, either beneath the free margin of the gum or still better into the circular ligament, to avoid the accumulated debris. A few drops of the solution are injected in order to produce superficial anesthesia. The needle is now forced into the peridental membrane and directed parallel with the long axis of the tooth for a short distance. Here about ten drops of the solution are injected. The same modus operandi is repeated distally, injecting another ten drops. (Figs. 164 and 165.) As the peridental membrane is continuous with the pulp of the tooth and the nutrient vessels and nerves, the anesthetic solution will be carried to the pulp quickly, producing satisfactory anesthesia on the tooth for any operation.

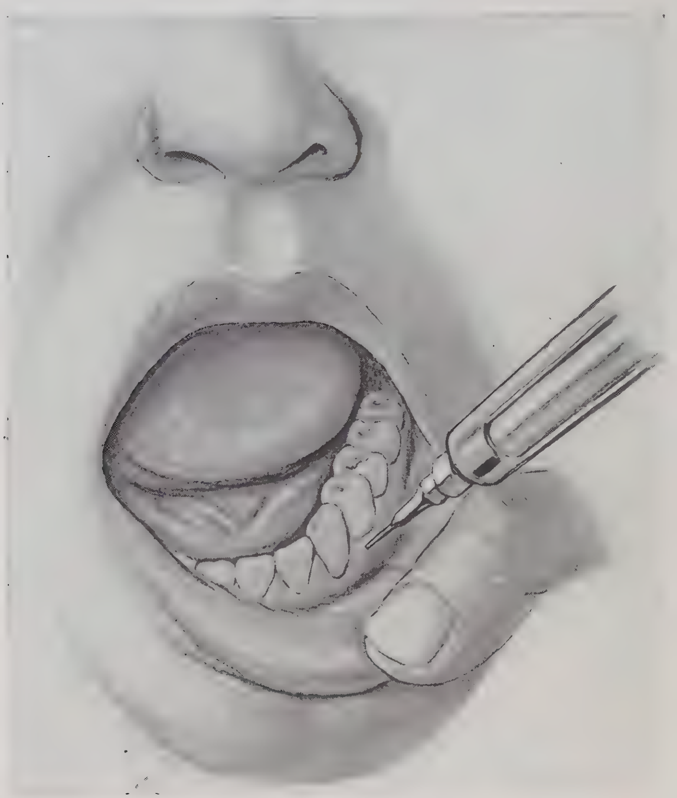


FIG. 166. Intraseptal injection shown on patient.

A peridental injection may be made in cases where the tooth stands alone, without adjoining teeth. When the teeth are contiguous and close to one another, they must be separated to enlarge the interdental space and expose the peridental membrane.

Disadvantages. The writer seldom resorts to this method of producing anesthesia. First, on account of the ever present danger of forcing infected debris into the peridental membrane and thus producing severe postinjection complications, such as pericemental inflammation, after-pain, sloughing, etc. Then again on account of the pain incident upon forcing the solution into the peridental membrane and the separation of the teeth in order to gain access to the interdental portion of the peridental membrane. Just as good results, with less pain and discomfort to the patient, may be obtained by a properly performed subperiosteal injection, fully described in the preceding pages.

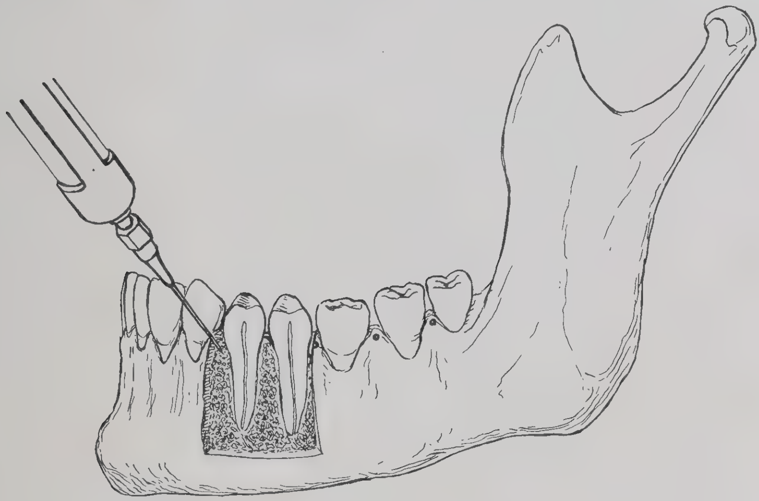


Fig. 167. Schematic drawing of mandible with part of the outer cortical layer removed to show intraseptal injection.

Intraseptal Anesthesia.

Peridental anesthesia is indicated particularly in young patients whose alveolar walls are not very dense and whose peridental membranes are more or less intact. In older patients, the peridental membrane attachment becomes scanty and the membrane itself recedes. The alveolar walls become dense so that the introduction of the needle into the peridental membrane, between the tooth and the alveolar wall, becomes difficult.

In such older patients many dentists are making intraseptal injections successfully. The injection is made into the septum of two adjoining teeth. This interdental septum is of a cancellous structure and the solution, when injected therein, will be rapidly absorbed by the sponge-like structure, proceeding then through the lacunæ and canaliculi, anesthetizing the terminal nerve filaments which innervate the alveolus and then reaching the peridental membrane and finally the pulp chamber. In patients advanced in years the cortical covering of the interdental septum will be somewhat absorbed exposing the porous structures, so that penetration with the needle may easily be accomplished.

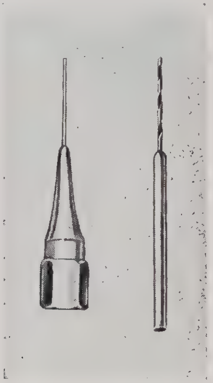


Fig. 168. Needle and drill used in intraosseous injection.

Needle and Syringe Employed. A short, 15 mm. 23 gauge needle, with a sharp point should be used. The needle should be mounted on an all metal or glass and metal type syringe which will withstand considerable pressure. A slip-on needle is not indicated, as it may be forced off the attachment in the process of injection.

Technique. Let us assume that a lower first bicuspid tooth is to be anesthetized. The points of puncture are thoroughly painted with tincture of iodin or a mixture of one part of tincture of iodin and two parts of acetone. The syringe is held tightly, in a pencil-like manner and the needle inserted into the interdental septum, between the first and second bicuspids, exerting sufficient force to penetrate the outer comparatively dense layer of bone in order to reach the cancellous portion. The bony wall of the septum will be found to be thin at this point. Should hand pressure be found insufficient, the piston of the syringe may be tapped gently with a light instrument to force the needle through the outer thin cortical plate of the septum. The solution is injected slowly under pressure. About 10 drops of a 2% procaine solution should be deposited, taking about one minute to complete this. (Figs. 166 and 167.) The same sort of injection is now made distally of the tooth, namely between the first and second bicuspids, again inserting the needle into the interdental septum, forcing it into the cancellous structure and taking another minute to deposit another 10 drops of the solution. Should it be desired to anesthetize the second bicuspid also, one additional injection will suffice, between the second bicuspid and the first molar. And again, the anesthesia of the first molar may be completed by an injection between the first and second molars. In this manner the tooth or teeth will be anesthetized completely either for extraction, extirpation of the pulp or any other operation.

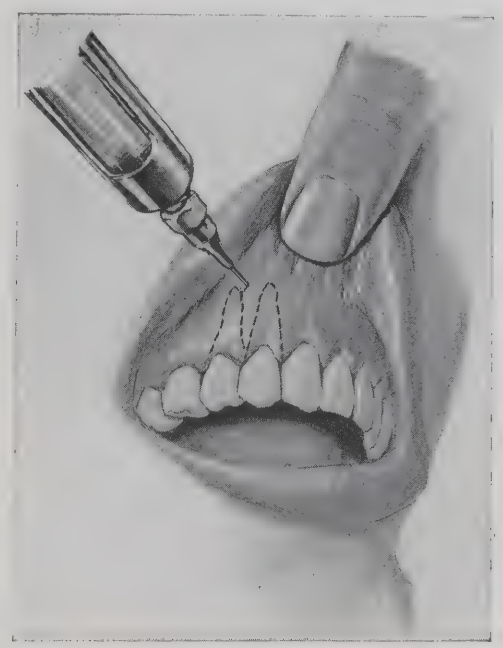


Fig. 169. Intraosseous injection shown on patient.

Advantages Over Peridental Injection.

This method of anesthetizing a tooth is preferable to the peridental method. The solution is not forced into the peridental membrane through the gingival space. Thus the danger of driving in the infected food debris is eliminated. The pain incident to peridental injection is avoided and finally, unlike the peridental injection, it is not necessary to separate the teeth to expose the peridental membrane.

Intraosseous Anesthesia.

Intraosseous injections are made into the cancellous structures between the two cortical layers of either the mandible or the maxilla. Thus diffusion of the solution is hastened.

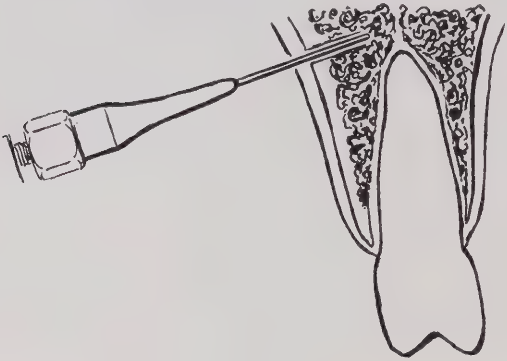


Fig. 170

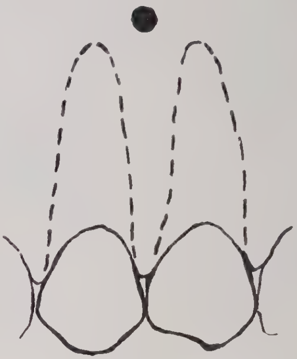


Fig. 171

Fig. 170. Diagram of bicuspid showing intraosseous injection with needle in the cancellous layer.

Fig. 171. Point of insertion of needle in an intraosseous injection.

Instrumentarium Employed. For this injection a round or fissure bur may be used. The bur should not be of larger diameter than a 21 gauge needle. A Gates-Glidden drill of the proper thickness may be used to good advantage. The needle employed should be about 15 mm. 21 gauge of either iridio-platinum or steel with a blunt point. A syringe should be selected which will withstand considerable pressure. (Fig. 168.)

Technique. The injection should be made slightly above and distally or mesially to the tooth it is desired to anesthetize in order to avoid all possible danger of injury to the roots of the tooth. The gum at the point of puncture should be thoroughly cleansed and aseptically prepared. A preliminary injection is made to produce anesthesia of the buccal mucous membrane and also partial anesthesia of the outer alveolar plate. About 1 cc. of a 2% procaine solution may be employed for this purpose. A slight incision of the mucous membrane is then made. The incised edges of the mucous membrane are pushed apart with some sterile gauze and held apart with a pair of cotton pliers; the outer plate is then perforated with the properly selected bur or Gates-Glidden drill. (Figs. 169 and 170.) It is easily determined when the bur penetrates the cortical plate and enters the cancellous structure. The sensation is the same as when a bur suddenly enters the chamber after going through dentin. The bur is now removed and the 15 mm. 21 gauge platinum needle inserted into the opening obtained. Another 1 cc. of the solution is very slowly injected into the cancellous strata of the maxilla, care being taken not to force the solution too quickly. Diffusion will take place very rapidly and anesthesia will be produced almost immediately.

For intraosseous anesthesia of the first upper bicuspid tooth, the injection should be made above and medially to the root of the bicuspid root. (Fig. 171.) For anesthesia of the upper first molar tooth, the injection may be made either between the two buccal roots or between the anterobuccal root of the first molar and the root of the second bicuspid tooth.

When Indicated.

Intraosseous anesthesia of the lower bicuspids and molars is contraindicated on account of the unusual thickness in the outer alveolar plate in this region, which makes the procedure difficult.

It appears to the writer that the average practitioner in his daily routine could perform his work painlessly without resorting to this method of producing anesthesia. Intraosseous injections are not indicated in infected and inflammed areas. In the absence of infection, a subperiosteal injection would produce the desired results with less inconvenience to the patient and anesthetist. The necessary preliminary injection in intraosseous anesthesia will sometimes suffice to produce sufficient anesthesia for the removal of the tooth. In the mandible, a mandibular injection, properly carried out, is more effective and more certain of results.

The terminal branches on the lingual plate will not always be anesthetized by intraosseous injection. It is frequently necessary to infiltrate the tooth lingually or make a posterior palatine or incisive injection to complete the anesthesia.

Intra-arterial Anesthesia.

The second great subdivision of local anesthesia, namely, conduction or nerve blocking, has been thoroughly discussed in the previous chapters.

The third subdivision of local anesthesia is the intraärterial method, by means of which the solution is carried into the arterial circulation, supplying the area which it is desired to anesthetize. The solution is thus distributed by the arterioles throughout every part of the operative field.

As far back as 1886 attempts were made to produce anesthesia for surgical purposes through the arterial route. Cocain was used as the anesthetizing agent. More recently, this method of diffusing the anesthetic solution to the periphery has been described by several surgeons. In the *Annals of Surgery* for the year 1910 appeared a description of several cases by Dr. Ransohoff, one of which is quite interesting. The following is his report on case 1.

> "Male, age 72. The patient has been suffering for three years from a chronic osteomyelitis of the hand, which became so painful as to necessitate an amputation. His age and condition contraindicated general anesthesia. Under infiltration anesthesia the brachial artery was exposed and the needle of a hypodermic syringe inserted into its lumen and 1 cc. of a 2% cocain solution injected into the artery in the direction of the blood current. In two minutes anesthesia was absolute and antebrachial amputation was done without the patient's knowledge. There are two features of special interest in this case: the rapidity of anesthesia and the fact that the operation was performed without the patient's knowledge. After the operation had been completed the patient asked when we would begin. This absolute anesthesia is a salient feature of this method, as well as one of the greatest advantages."

Intraärterial anesthesia can be of but little value to the dental surgeon. Direct injection into an artery is not a very easy task. The tissues must first be dissected away, the artery exposed and then the needle introduced into the lumen.

It is the writer's opinion, however, that unintentional intraärterial injections are sometimes made by the dental surgeon. For instance, the characteristic blanching of the skin following an injection, at some point quite distant from the original puncture and injection, may be explained by an intraärterial injection. The solution is carried by the blood current and causes contraction of the muscle coat of the arterioles due to the vasoconstrictor action of the supranol incorporated with the anesthetic agent. It is also quite possible that there may be absorption of the anesthetic solution through the arterial walls. This theory would help to explain the anesthetization of the pulp in a subperiosteal injection. The arteries of the pulp enter the pulp canal at the apical foramen and ramify into a very rich network. It is a noteworthy fact that the alveolar wall is anesthetized first, followed later by the anesthetization of the pulp. The arteries supplying the arterial wall are nearer to the injected solution and therefore would be prone to absorb it first, and then carry it to the pulp chamber.

It is authoritatively stated that the intraärterial lethal dose of an anesthetic is from eight to ten times greater than the intravenous, inasmuch as the arterial current is away from the heart, while the opposite is true with the venous circulation. However, in dental anesthesia, the injections into an artery may be just as toxic as an intravenous injection on account of the direction of the blood current toward the central nervous system.

Intravenous Anesthesia.

Anesthesia of a desired area may also be produced by injecting the anesthetizing agent into the venous circulation of that area. It is necessary to bandage the distal end of the operative field to prevent a free venous flow, which would carry away the anesthetic solution and thus prevent the confining of its action to the desired area.

Intentional intravenous anesthesia is also of no value to the dental surgeon. Intravenous injections, however, are often made unintentionally in the various nerve blocking injections. As explained in previous chapters, the anesthetic solution may be erroneously injected into the posterior facial vein in a mandibular injection; into the pterygoid plexus of veins in a tuberosity injection; and into the angular or infraorbital veins in an infraorbital injection. It is doubtful, though, whether any anesthetic effect can be produced by such injections, as the solution is rapidly carried away by the blood current.

Pressure Anesthesia.

The anesthetization of the dental pulp by means of forcing the anesthetic solution into the pulp tissues is being practiced by many operators with marked success. Either cocain or procaine may be used in this procedure.

Tablets Employed. Especially prepared billets are being marketed for the purpose of anesthetizing a pulp by pressure anesthesia. These billets consist of either 1/12 gr. cocain or 1/6 gr. procaine with 0.01 gram supranol. The writer prefers the procaine billets to the cocain. There are cases on record where the use of cocain in pressure anesthesia has resulted in severe toxic disturbances due, no doubt, to the absorption of the cocain by the blood vessels of the pulp and carrying it into the circulation through the apical foramen. These billets are specially molded into cylindrical shape, so that they may be easily introduced into a tooth cavity. They also easily disintegrate in moisture, a very essential feature to enable the ready formation of a concentrated procaine or cocain solution.

Technique. The tooth should be isolated by a rubber dam. The food particles and débris are then thoroughly removed. The action of the anesthetic will be quicker when in direct contact with the pulp tissue, than when it acts through an intervening layer of decalcified dentin. It is desirable, therefore, to fully expose the pulp prior to the application of pressure anesthesia. This may be accomplished by using ethyl chlorid to deaden or obtund the dentin. The technique for using ethyl chlorid will be described next.

The cavity walls are now treated with an application of chloroform on a pledget of cotton. This is to dissolve any organic matter which may be present. Next the cavity is sterilized by an application of phenol on a pledget of cotton in order to prevent any infected matter being forced through the pulp tissue and beyond the apical foramen. A pressure anesthesia billet is now introduced into the cavity, followed by a drop of sterile water. The procaine billet will thus partially disintegrate in the cavity. The billet is now covered by a small piece of spunk or cotton, and the cavity completely filled with a piece of beeswax. The wax should be large enough to fully cover all margins of the cavity, and should be used as hard as possible to freely force it into the cavity. It is introduced at first with only gentle pressure, and is then allowed to rest a full minute, after which gentle but continuous pressure should be resumed for half a minute longer. After a rest of another half minute a large egg-shaped burnisher is forced through the wax in the direction of the long axis of the tooth. Often this produces no pain; at other times there is a sharp but short twinge, which almost immediately subsides, upon which the pulp may be painlessly removed.

When pressure anesthesia was first introduced, the technique recommended included the use of unvulcanized rubber with which to fill the cavity and cover the pledget containing the anesthetic agent. Modern practitioners, however, prefer the wax as it seals the cavity more tightly, preventing undue escape of the anesthetic.

In pathological conditions, when the pulp has been undergoing some changes, or in cases of pulp stones or secondary dentin, or when there is a healthy intervening layer of dentin, several applications would be found necessary in order to produce the desired results. In such conditions as much of the original, or secondary dentin as possible should be removed with chlorid of ethyl anesthesia. The supranol combined with the pressure anesthesia billets not only helps the anesthetic action but acts as a vasoconstrictor to the blood vessels of the pulp producing, therefore, a more or less bloodless pulp removal.

Anesthesia for Pulpotomy.

Pressure anesthesia may be used in pulpotomy where it is desired to amputate the pulp. Arsenical applications in such cases of course are contraindicated, as death of the pulp will preclude all possibility of the formation of osteoid tissues and the eventual closing up of the foramen. There is, however, a remote possibility of pulp strangulation in pressure anesthesia. The safest method of anesthetizing the pulp for the purpose of performing pulpotomy or partial pulpectomy would be nerve blocking. Infiltration anesthesia by the subperiosteal method is the most effective and the second in safety.

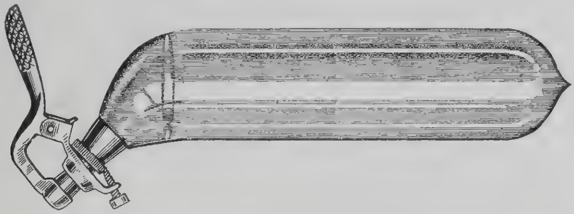


Fig. 172. Glass ethyl chlorid container.

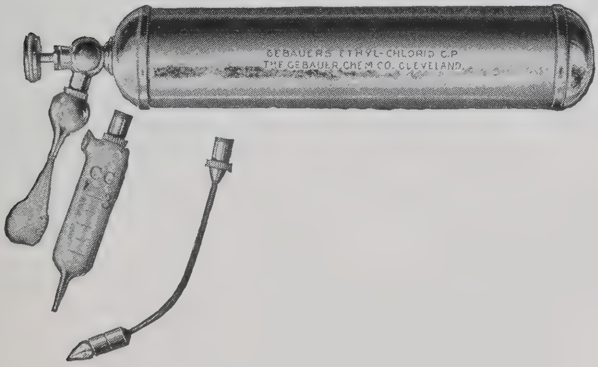

GEBAUER'S ETHYL-CHLORID C.P
THE GEBAUER CHEM CO. CLEVELAND

Fig. 173. Metal ethyl chlorid container.

Obtunding Dentin with Ethyl Chlorid.

The chemical formula of ethyl chlorid is C_2H_5Cl. It is a highly volatile, colorless liquid, very inflammable. On account of its volatility, ethyl chlorid is supplied only in hermetically sealed glass or metal containers. For convenience and ease of administration, the tubes are supplied with specially constructed metal caps which by pressing a small lever permit the escape of a very fine stream of the ethyl chlorid. The rapid evaporation of ethyl chlorid when it comes in contact with the tissues produces a lowering of temperature and anesthetization of the terminal nerve endings.

The obtunding or anesthetization of dentin by freezing was first prominently brought to the attention of the dental world by Dr. R. Ottolengui who claimed that he could freely cut the most sensitive cavities, by first using a spray of ether. Dr. Ottolengui used an ordinary double bulb atomizer. Similar and better results were later obtained with methyl chlorid. This method was never popular because the containers were cumbersome and so large as to be useless in some locations.

With the introduction of ethyl chlorid in convenient metal containers and glass containers (Figs. 172 and 173) the obtunding of sensitive dentin was really solved, although strange to say the method is not utilized to the extent which it deserves. This is probably due to improper technique.

Technique for Obtunding Dentin with Ethyl Chlorid.

After the cavity has been cleansed of food and such loose particles of decay as may be removed without pain, a pledget of cotton is dipped in ether and placed in the cavity. This causes a slight shock, but not so great a shock as when the ethyl chlorid is introduced into a cavity that has not been previously partly chilled in this manner. Next, the ethyl chlorid is sprayed directly upon the cotton. This may produce a shock and cause a remonstrance from the patient. The dentist should immediately soothe the patient with the assurance: "Just a moment now and it will cease to hurt and then we can drill out that cavity absolutely without pain." In a very few moments the ether saturated cotton can be removed, thus permitting the spray to reach the cavity direct. Many operators have failed to get satisfactory results, by stopping the spray too soon. It should be continued for a considerable time, so that when stopped a collection of frost is seen in and about the cavity. This may be removed easily and the cavity can be prepared absolutely without pain, though this must be done swiftly, as the anesthesia, if anesthesia it may be called, is very brief. It is wiser to make a second application of the spray, rather than to cause pain after promising a painless operation.

A very useful application of ethyl chlorid is for the exposing of pulps prior to pulp extirpation by pressure anesthesia. It should be remembered that the nearer the pulp is to full exposure the greater the shock of the first application of the spray would be. Hence precautions should be observed. The ether saturated cotton should be renewed two or three times before using the ethyl chlorid, and while the ethyl chlorid spray is being used it should be left within the cavity longer than in ordinary circumstances.

Ethyl chlorid cannot be relied upon for use against the soft tissues of the oral cavity, and these should be protected by having the dam in position. In addition to this, cotton rolls should be packed about the cavity to receive the excess or overflow. Otherwise this escapes into the mouth and is quite irritating, causing coughing and the like. Where the use of the rubber dam is impossible, as in cavities partially below the free margin of the gum, the cotton rolls must be carefully packed about the tooth.

Ethyl chlorid serves a very useful purpose in another direction. Patients have become quite accustomed to the idea of hypodermic injections in the arm or other parts of the body as practised by physicians, but some are apt to be nervous or afraid when it is suggested to introduce the hypodermic through the face, as has been described in the technique given for extraoral injections. By the use of the ethyl chlorid spray the surface of the face can be so thoroughly numbed that the introduction of the needle is absolutely painless. Indeed some physicians now carry a tube of ethyl chlorid with them for use when making injections for nervous or timid patients.

CHAPTER VIII.

PHARMACOLOGY OF DRUGS USED IN LOCAL ANESTHESIA.

Local anesthesia by means of injection of an aqueous solution into the tissues was given its first impetus by Karl Koller in 1884. He demonstrated the use of cocain as a local anesthetic for operations upon the eye, nose, throat and other parts of the body. Since then the progress of local anesthesia has been very rapid and astonishing. Cocain was uniformly adopted as a local anesthetic for surgical operations. Its indiscriminate use, however, resulted in many fatalities due to its toxic properties. Besides, it was soon discovered that cocain by virtue of its cerebral and muscular stimulation possessed habit-forming properties, which often rendered its victims physical and moral derelicts. This led many investigators to look for a substitute possessing the anesthetic properties of cocain, yet without its disagreeable features.

Chemically, cocain is the methyl-benzoyl-ester of ecgonin expressed by the following formula: $C_{17}H_{21}O_4N$. Upon decomposition, cocain breaks up into the following products: ecgonin, benzoic acid and methyl alcohol. It appears that the anesthetic properties of cocain depend largely upon ecgonin or some substance analogous to it which contains a benzoyl and an alkyl radical in certain relations.

The benzene ring constitutes the foundation upon which organic research workers have endeavored to build up, by certain changes, organic products, which would have a physiological action similar to cocain upon the sensory nerve tissues.

The first substitute for cocain was tropacocain, isolated in 1891. It is less toxic than cocain and almost as effective. Then followed eucain in 1896. These two cocain substitutes, although not quite as toxic as cocain, still were far from ideal, inasmuch as they possess many of the disadvantages of cocain.

Later, the attention of the research workers was directed toward the alkyl compounds of the esters of the amino acids, (an ester designates the combination of an organic acid with a phenol or alcohol), all of which appeared to possess marked anesthetic properties.

Orthoform was the first local anesthetic of this group to be developed by Einhorn and Heinz in 1898. On account of its insolubility in water and its irritating properties, orthoform gained but very little favor with the profession. The same may be said of the anesthetics which followed orthoform closely, namely, nirvanin, holocain and acoin.

The orthoform group of anesthetics led to the discovery of anesthesin in 1901. This was accomplished by eliminating the hydroxyl group from orthoform and obtaining the ethyl ester of para-aminobenzoic acid. Anesthesin (novesthene) is insoluble in water and for that reason cannot be used for subcutaneous injections, although it possesses remarkable anesthetic properties. Unlike orthoform, anesthesin (novesthene) is non-irritating; on the contrary it stimulates injured tissues toward granulation.

The next step in the search for an ideal anesthetic was the discovery of stovain, by a French chemist in 1904. Stovain is strongly acid in reaction and produces considerable irritation following its injection into soft tissues. Alypin was an improvement, but this, too, displays marked irritating properties in soft tissues.

Procaine.

Finally, in 1905, Einhorn and Uhlfelder, encouraged by the preceding extensive experimental work, and discoveries in the field of local anesthetics, centered their attention again on the salts of the alkaminester of aminobenzoic acid. From anesthesin, one of that group, they produced various compounds that possessed anesthetic properties of greater or lesser degrees. The culmination of their experiments was novocain, known in America as procaine, the chemical name of which is the hydrochlorid para-amino-benzoyl-diethyl-amino-ethanol, and is expressed by the following formula: $NH_2C_6H_4COOC_2H_4N(C_2H_5)_2HCl$.

Procaine appears to be the nearest to the ideal of all local anesthetics so far developed and offered to the medical and dental professions. It is a white crystalline powder, melting at 312° F. or 156° C. It replaces cocain in so far as its anesthetic properties are concerned. It is almost as potent as cocain in the intensity and duration of its anesthesia. The toxicity of procaine is considered to be about one-sixth that of cocain. Procaine is non-irritating to the soft tissues. It is readily absorbed by the tissues without producing any disturbances, which is a most desirable quality in an ideal local anesthetic. It is readily soluble in water, making hypodermic injections possible. It happily combines with the pressor principle of the extract of the suprarenal medulla, another admirable characteristic in an ideal local anesthetic. Procaine may be heated to 300° F. without decomposition. This, too, is a valuable property inasmuch as procaine solutions may be sterilized by boiling without fear of decomposition. And last, but not least, procaine is not habit-forming.

Procaine, or as it was formerly known, novocain, is manufactured by several pharmaceutical firms in the United States. Formerly, it was solely imported from Germany and during the world war it was, at times, totally unobtainable. In 1917 our Government issued licenses to several reputable chemical manufacturers to manufacture novocain in this country, with the provision, however, that this drug should be known by its American name, procaine. At the same time, steps were taken to assure the chemical identity and purity of the product. Since procaine has been made in this country the writer has been using the product manufactured by the Novocol Chemical Manufacturing Company and which is distributed under their trade name novol. All references in this book are made under its proper name as suggested by the Federal Trade Commission, namely, procaine.

Procaine has now become the most widely used local anesthetic, not only in the field of dental surgery but also for operations upon the eye, nose, throat and pharynx. It is being more and more adopted by the medical profession in major surgery and is gradually replacing general anesthetics in such operations as laparotomies, thyroidectomies, etc. Local anesthesia is found to be safer than deep narcosis and is less likely to produce shock, the frequent aftermath of surgical operations.

Of the more recent synthetic substitutes for cocain, mention must be made of two American products, aposthesin and butyn.

Apothesin.

Aposthesin is a combination of cinnamic acid and propyl alcohol and is chemically designated as the hydrochlorid of gamina-diethyl-amino-propyl-cinnamate. It occurs as a white crystal, very soluble in water, readily soluble in alcohol, and faintly soluble in acetone and ether.

The anesthetic effect of apothesin is said to be equal to that of procaine. It has been proven, however, that in intravenous injections in animals, the fatal dose of apothesin is about half of that of procaine, and it is therefore about twice as toxic as procaine.

Butyn.

Of still more recent development in the American synthetic chemical industry is butyn. The chemical name of this anesthetic is para-aminobenzol-gamma-di-n-butylamino-propanol sulphate.

The manufacturers of butyn state in their report that in animal experimentation in subcutaneous injections butyn was found to be more toxic than cocain. They also state that in humans it appears to be less toxic than cocain. This, however, holds true for other local anesthetics, and therefore, it appears to the writer, that the ratio of comparative toxicity of the various anesthetics holds true to animals as well as humans, and apothesin or procaine should in proportion have the same decreasing ratio of toxicity as the scale toward higher animals is ascended. Butyn has not as yet been used in sufficiently large number of cases to determine its toxicity index in humans. It is apparent, however, that it is more toxic than procaine and therefore should be used with caution. Dr. H. E. Tompkins, experimenting with the drug with the intention of using a 2 cc. of a 1% solution of butyn on one hundred patients was compelled to abandon the attempt on his 42nd case. Four cases of toxicity had developed, the last case, his 42nd, was of a quite alarming nature.

The ideal anesthetic the profession is looking for and for which the pharmaceutical chemists are aiming should be less toxic than procaine and at least equal in its anesthetic strength.

Epinephrin.

Epinephrin is the name adopted by the U. S. Pharmacopeia for the active principle of the medullary portion of the suprarenal gland. This alkaloid is known under various trade names, given to it by pharmaceutical manufacturers, such are adrenalin, supranol, suprarenalin, etc.

The two suprarenal glands are located in the epigastric region, each one resting upon the upper border of the kidney. The gland tissues consist of an outer cortical portion and an inner medullary portion, the latter being of a dark soft consistency. The suprarenal capsules are ductless glands, discharging their internal secretions from their medulla directly into the blood circulation. Their function and secretions are essential to life, for when excised, death of the animal follows in a few hours, preceded by a rapid fall in blood pressure.

The active principle of the suprarenal medulla has been isolated by different research workers. Abel isolated it in 1897 and called it epinephrin. Takamine, working independently, isolated the active principle in 1901 under the name adrenalin.

The epinephrin or supranol base is a greyish white powder slightly alkaline in reaction and slightly soluble in water. For this reason some salt, such as the hydrochlorid or bitartrate, is used for the purpose of making an aqueous solution. When injected into the tissues, even in very minute quantities, it acts as a powerful vasoconstrictor, thus temporarily raising the blood pressure. The action is not exerted upon the blood itself but upon the involuntary muscle fibers located in the peripheral blood vessels. The smooth muscle fibers are innervated by the sympathetic nerves and the theory is advanced that the influence of supranol is not only upon the smooth muscle coat of the arterioles but also upon the peripheral sympathetic nerve endings which control the contraction of the involuntary muscles. Thus a powerful vasoconstrictor action is obtained, resulting in ischemia or local anemia. Supranol is therefore one of the best hemostatics available to the surgeon.

With the advent of epinephrin or supranol, local anesthesia was given a great impetus. Many advantages are gained by combining the local anesthetic agent with supranol. Less of the solution is required to anesthetize a certain area because the vasoconstrictor action of supranol will confine the injected solution to the desired area by preventing absorption into the circulation. The anesthesia will be prolonged and intensified. By virtue of its vasoconstrictor properties a more or less bloodless field is obtained for surgical procedure. At the same time, the heart is indirectly stimulated in its endeavor to overcome the peripheral contraction of the arterioles. The blood pressure is markedly increased. It is evident that supranol is a valuable adjunct to the local anesthetic employed.

When given in ordinary doses, supranol does not produce any after reaction. The established local anemia is but temporary, the tissues gradually return to normal. There appears to be no interference with the healing of the wound. When too large doses are used, the profound and prolonged ischemia produced may cause death of the cells and sloughing of the part.

Following the prolonged anemia, a reactionary hyperemia may set in, due to a vasomotor paralysis. In such cases secondary hemorrhages may occur. For dental purposes, supranol is used in combination with the local anesthetic solution in very small doses. It may be combined in solutions ready prepared or incorporated in tablets from which the operator prepares his own solution as necessity requires.

It should be understood that supranol, in itself, is not a local anesthetic, but it has the property of increasing the potency of the anesthetic with which it is combined. The advantages accruing from the use of this valuable drug have been enumerated above. The rapid development of local anesthesia owes a great deal to the active principle of the suprarenal medulla.

Within the last decade or so, the active principle of the suprarenal capsule has been prepared synthetically. A number of these preparations have been introduced in recent years under various names, such as: epinin, arterenin, homorenon and suprarenin synthetic. Epinin is about ten times less potent; homorenon is fifty times less toxic and fifty times less active than supranol or adrenalin. The writer, some years ago, experimented with epinin, and although it was found to be about ten times less active, yet it appeared to be more toxic than adrenalin or supranol. Of all the synthetic products, suprarenin synthetic appears to be more effective and the nearest in its action to the natural product.

There has been a great deal of controversy as to the comparative value of the synthetic substitutes and the physiologically active principle of the suprarenal capsule. Allen in his latest book, "Local and Regional Anesthesia," compares the two as follows:

> "The synthetic preparations of adrenalin have until recently been little used in this country, surgeons preferring the natural product, which has so far proved best and has answered all requirements; all that synthetic chemists have attempted is to imitate adrenalin, none have surpassed it."

The writer, in all his clinical work, uses the natural product, preferring it to any synthetic substitute. By carefully comparing the actions of each, the natural product gives greater satisfaction at his hands. It appears to be slightly more stable and may be sterilized with a greater degree of safety when compared with the synthetically prepared products. Both the organic and synthetic products will oxidize very readily, particularly when exposed to the air or to the slightest alkalinity. Metals, particularly the minutest traces of iron, will cause rapid oxidation.

It is conceded by some investigators that when the natural product oxidizes, it loses some of its strength, depending upon the degree of oxidation. When it turns pink, only a very slight loss of its pressor principle will take place. The solution still may be used with safety. It is only when the solution turns a dark brown color that the vasoconstrictor properties will be entirely lost; then the solution should be discarded.

Dr. Arthur E. Smith in his book, "Block Anesthesia and Allied Subjects," page 267, has the following to say on the subject:

> "It can be said that when the solution is of a slightly amber color, and is prepared from the organic adrenalin, it does not alter the therapeutic efficiency or the power to produce toxic symptoms. It has been the experience of numerous operators, also the writer's experience, in making deep nerve blocking injections, employing the solution when it is slightly amber colored, that no more toxic symptoms have been noticed than when the solution is perfectly colorless."

And again Dr. Louis Schultz, in discussing a paper on local anesthesia by Dr. Puterbaugh at a meeting of the Illinois State Dental Society, has the following to say as to the relative value of the natural extract of the suprarenal capsule and its synthetic substitutes. This appeared in the January, 1920 issue, page 47, of the *Journal of the National Dental Association.*

> "A word with reference to the use of suprarenin or adrenalin in the solution. The statement is frequently made that adrenalin is not of uniform strength while suprarenin is. That is what is claimed for suprarenin by its manufacturers. As a matter of fact adrenalin is standardized, is of uniform strength and can be absolutely depended upon. The same is true of a solution which is freely used all over the country by both the medical and dental professions. As to the stability of the two agents, I believe that they are about evenly matched, at least they are alike so far as practical purposes go. For instance, adrenalin may be boiled three different times over an open flame for fifteen minutes without loss of activity after the second boiling and but slight loss after the third, while suprarenin shows a slight loss after the second boiling and more after the third. There is, however, this difference: a solution containing suprarenin which becomes pink on boiling should be discarded because of the great toxicity of the partially oxidized suprarenin, while a solution containing adrenalin of similar color may be used with just as much safety as a perfectly clear solution, the only change in this solution being a slight loss of activity of the adrenalin due to such deterioration, but no increase in toxicity."

The manufacturers of adrenalin showed a willingness to cooperate and, at the request of the writer, have supplied some valuable information and data as to the relative stability and efficacy of adrenalin and the synthetic product. They have supplied the writer with an interesting reprint of a paper by L. W. Rowe on "The Sterilization of Adrenalin Solution," which appeared in the *American Journal of Pharmacy,* April, 1914, pages 145-149. The following extract from this paper throws considerable light upon the subject:

> "The next experiments give a comparison of the stability of adrenalin chlorid solution 1 in 1000 with that of an analogous synthetic substance of equal physiologic activity. The latter was made by treating the crystals with dilute hydrochloric acid and diluting 1 in 1000. The adrenalin chlorid solution used was made from C.P. adrenalin crystals and contained no preservative

other than a slight excess of hydrochlorid acid. The solution was tested and found to possess standard activity.

"Three different procedures were followed in sterilizing the solutions, but the conditions were duplicated for each solution in order to obtain a direct comparison. The conditions to which the solutions were subjected will be briefly stated and the results placed in the form of a table so as to give a better opportunity for comparison.

"In the first method of this series 10 cc. of the 1 in 1000 solution to be sterilized was placed in a graduated cylinder, which was then plugged with cotton, and gradually heated in a water bath to the temperature of boiling water. This temperature was maintained for 15 minutes, and at the end of that time the solution was cooled, made up to its original volume if any loss due to evaporation had occurred, and one cubic centimeter removed for testing. This process was repeated four times.

"In the second method 25 cc. of the solution to be sterilized was placed in a tightly corked bottle, which was then partially immersed in boiling water for periods of 15 minutes each. Under these conditions there was no loss by evaporation. Each solution was submitted to four periods of sterilization and a test of its activity made after each period.

"In the third method of this series 20 cc. of the solution to be tested was placed in a small open flask and boiled over a flame for 5 minutes. After each period of boiling the loss due to evaporation, which was considerable, was made up with distilled water and the activity of the solution then determined.

"The results of the above experiments were all checked and are summarized in the following table:

	Solution of Adrenalin Chlorid				Solution of Synthetic Substance			
	1st ster. per cent	2nd per cent	3rd per cent	4th per cent	1st ster. per cent	2nd per cent	3rd per cent	4th per cent
First Method								
Cotton plugged tube in boiling water 15 minutes at a time	1.100	100	90	80	1.100	100	80	80
	2.100	100	90	90				
Second Method								
Tightly stoppered bottle in boiling water 15 minutes at a time	1.100	100	100	90	1.100	100	70	70
	2.100	100	90	90	2.100	90	80	80
Third Method								
Boiled 5 minutes over flame in open flask	1.100	100	90	75	1.100	90	80	75
	2.100	100	100	90	2.100	90	80	80

"The results obtained show that adrenalin chlorid solution 1 in 1000, containing no preservative other than a slight excess of

> hydrochloric acid, can be sterilized at least twice by heating to the temperature of boiling water under various conditions without losing any activity. After this the loss is quite gradual, so that it probably would not be noticeable therapeutically until after the fourth or fifth sterilization. By a comparison of the results obtained with adrenalin chlorid solution and the solution of the synthetic substance, it can be seen that the loss of activity due to sterilization occurs more quickly in the case of the latter solution, and also that the deterioration is more marked.
>
> **Summary.**
>
> "1. Adrenalin chlorid solution in ampules can be heated continuously for 3 hours to the temperature of boiling water without any loss of activity.
>
> "2. Adrenalin chlorid solution in ampules can be sterilized by immersion in boiling water for seven distinct periods of 15 minutes each without loss of activity.
>
> "3. Adrenalin chlorid solution can be exposed to the air and sterilized at least twice under a variety of conditions without loss of activity.
>
> "4. Adrenalin chlorid solution is more stable than the solution of a synthetic compound when both are subjected to the same sterilization treatment.
>
> "The results obtained disprove the statement that the stability of the synthetic exceeds that of the natural product."

To supplement the above the writer would also like to quote part of a letter received from Dr. F. D. Francis, of Parke, Davis & Co., in response to an inquiry:

> "We have satisfied ourselves very fully, as is shown by the last mentioned reprint, that natural adrenalin is distinctly more stable than the synthetic. Why this is so we are not prepared to say positively but it seems to us that the presence of dextro-adrenalin or perhaps other traces of foreign substances produced in the process of making adrenalin synthetically are responsible for its inferior stability.
>
> "We have also tested the effect of higher temperatures than that of boiling water upon adrenalin solutions with the following results:
>
> "Two samples 1:1000 solution we treated for fifteen minutes in an autoclave to a temperature of between 110° and 115° C. and these solutions showed no loss of activity on re-testing.

> "In addition to this, tests that we have made frequently during the past two years, upon the commercial solutions made by some of these manufacturers using synthetic suprarenin have in every case tested below our standard for adrenalin. Four such tests upon the same product ranged from 70% to 80% of our standard by physiological test. The chemical tests will of course give different and higher results, as both the dextro and levo adrenalin respond to the chemical tests in the same way. For example, one lot of the synthetic solution tested in both ways showed 70% of standard physiological test and 107% of the chemical test. Apparently an additional quantity of the synthetic substance had been used to bring the solution up to the strength equal to our standard."

The writer's personal experience has taught him to regard the natural product more favorably, provided it is carefully isolated from the suprarenal capsule, purified and standardized. It is just as stable as the synthetic and may be safely brought to the boiling point for the purpose of sterilization. Its pressor action may always be relied upon. But what appears to him to be the most important point of advantage is that when the natural product slightly oxidizes, it may be used with perfect safety, except for the very slight loss of the vasoconstrictor action. The writer would not hesitate to use a pink solution of procaine with supranol or adrenalin, and as a matter of fact has used a great quantity of such solutions without any postinjection complications or any toxic disturbances. When the solution assumes a darker hue, such as dark brown or chocolate color, it should not be used, because its physiological action has been greatly reduced or else is entirely destroyed.

The active principle when isolated from the suprarenal capsule is lævorotary. The synthetic product may be either dextro or lævorotary. The two seem to be identical in appearance and their chemical structure, yet the dextro is inactive while the lævo is active. In preparing the synthetic product, care must be exercised to separate the dextro and lævo components and the failure to do so results in an unsatisfactory product.

Supranol, on account of its powerful vasoconstrictor action and property of greatly increasing the blood pressure, should be used in very small doses and with great caution. Not more than 10 minims of 1 : 1000 solution should be injected into the tissues at one time. More may be used when it is distributed in a large area and in greatly diluted solutions. The dose, of course, will vary with age and, also, the condition of the patient. Less of the drug should be used in children, aged, weak, anemic and arteriosclerotic patients.

CHAPTER IX.

VEHICLE USED FOR LOCAL ANESTHETICS.

In making an aqueous solution of the local anesthetic employed for the purpose of injection, either a physiological salt or Ringer solution is used as the vehicle.

We must remember that the tissue cell is surrounded by a semipermeable membrane, enclosing cell contents of a certain density. By a semipermeable membrane we mean one that is permeable to water but not to the various salt ingredients the cell contains. Suppose we inject plain distilled water into the tissues. What happens? The salt ingredients of the cell content cannot pass into the injected fluid. However, there is greater osmotic pressure outside the cell than there is inside the cell. The result will be that, by virtue of the established difference in pressure and by filtration, some of the injected water will find its way into the cell. The cell will swell. This condition is known as hemolysis, when applied to the erythrocytes of the blood. The injected water is a hypotonic solution to the cell contents, or a solution which is deficient in salt constituents as compared to the cell content.

On the other hand, should the injected solution consist of a highly concentrated salt solution, exceeding the salt content of the cell, just an opposite action will take place. Water from the cell will pass into the surrounding injected fluid, as the osmotic pressure will now be exerted from the cell. The cell will shrink, producing a condition that is called plasmolysis. The injected solution in this case is a hypertonic solution being richer in salt ingredients than the cell content.

A solution which has the same density as the cell content and which exerts no osmotic pressure when injected into the tissues is said to be an isotonic solution.

By experiments, it has been determined that solutions of the same freezing point are isotonic to one another, so that when separated by a permeable or a semipermeable membrane there will be no pressure exerted in either direction.

The freezing point of the blood has been determined to be 0.56°. In other words, a solution which is of the same freezing point will be isotonic with the fluids of the human body.

Osmosis plays an important part in many vital physiological functions of the body, where there are present many aqueous solutions of various densities separated one from another by membranes. For instance, the carrying of nourishment from the blood to the cells by the lymph channels is accomplished to a great extent by osmotic pressure; the elimination of the waste matter by the epithelial walls of the tubules of the kidney, separating the blood and lymph from the urine; the secretions of the glands; the absorption of the nourishing elements from the digested food by the blood vessels and many other important functions continuously going on in the body, are accomplished to a great extent by osmotic pressure.

Experiments have been carried out by Braun to determine the degree of osmotic tension of salt solutions in various degrees of concentration. He began by injecting into his own skin, at first, lukewarm water; a wheal was obtained accompanied by pain and by anesthesia. A 0.1% salt solution was next injected. This was accompanied by a smaller wheal, less pain and less sensory paralysis. The strength of salt concentration was gradually increased to 0.2%, 0.3%, 0.4%, and so on until 0.6% was reached. Less pain, swelling and sensory paralysis took place as the percentage of salt increased until finally at 0.6% of salt there was no disturbance of tissue whatsoever. No pain, no irritation, no paralysis was produced by gradually increasing the salt concentration until 2.5% was reached, when again severe disturbances occurred on account of the injection of a hypertonic solution.

The correct deduction from these experiments appears to be that a concentrated solution of from 0.6% to about 2.5% of salt apparently does not produce any tissue changes. However, it is well to remember that a hypotonic solution is preferred to a hypertonic and that a 2.5% salt solution is entirely too concentrated to be easily tolerated by the tissues.

A solution of 0.9% salt concentration is the nearest to the freezing point of the body fluids and is therefore the nearest in isotonic tension to the tissue cells.

While it is desirable that the density of the anesthetic solution should be as near to that of the blood as possible, yet the maintenance of absolute isotonicity is not so important as some writers are trying to make one believe. One good reason is that isotonicity is unobtainable unless the freezing point of the anesthetic solution be brought to that of the blood of the patient. Tonicity varies in different individuals and even in the same individuals in different states of health and under different conditions. If our anesthetic solution be anywhere between 0.5% and 1% density we may inject it safely without danger of interfering with the normal function of the cells or of producing either hemolysis or plasmolysis. Therefore, boiling a 0.5% salt or Ringer solution will not produce a hypertonic solution unless the solution has been boiled down to less than half of its original volume.

At the same time it must be remembered that about a 5% procaine solution will approximately correspond to a normal salt solution in density and may be injected without any addition of salt ingredient. A 2% procaine solution, the strength usually employed in dental anesthesia, will, in itself, represent nearly half the required density for the injecting solution. Thus the 0.5% content of sodium chlorid in the saline solution is an advantage.

There is a question in the writer's mind whether it is not advantageous to inject a solution which is not isotonic with the cell contents. Remembering that the difference in tonicity is an important factor in the interchange of the nutrient element of the blood with the waste elements of the cell, is it not plausible that a slight variance of tonicity of the injecting solution with that of the tissue cells may help the combination of the protoplasm of the nerve cells with the anesthetic and thus accelerate anesthetization? However, the injecting solution should not be strongly hypertonic, but rather it should be hypotonic. In other words, the absorption of the anesthetic solution into the cell may help to establish anesthesia but it will not cause the water constituents of the cell to migrate into the anesthetic solution to cause the contraction and breaking down of cells.

The proper vehicle, then, as a solvent for the local anesthetic, should be either a normal salt or Ringer solution. A salt solution will answer the purpose just as well. A Ringer solution, besides the sodium chlorid, contains small quantities of potassium and calcium chlorid, simulating the salts in the blood plasma. It has been found that calcium chlorid exerts a stimulating effect upon the heart. It is said that the addition of minute quantities of calcium increases the vital functions of the leucocytes, thereby increasing resistance to infection. It is for these reasons the calcium and potassium salts are incorporated in the solution and not because the very small percentage will in any way modify the tonicity of the solution.

Ringer tablets are offered to the profession in two strengths, A and B.

Each A Ringer tablet contains:

Sodium chlorid	0.05 gram
Calcium chlorid	0.004 gram
Potassium chlorid	0.002 gram

One Ringer tablet dissolved in 10 cc. of distilled water will result in a solution that does not produce any change in the tissue cells upon injecting. To make up one ounce of Ringer solution, three Ringer tablets should be used.

Each B Ringer tablet contains:

Sodium chlorid	0.025 gram
Calcium chlorid	0.002 gram
Potassium chlorid	0.001 gram

The B tablets, then, contain half the quantity of the chlorids as the A tablets. Each one of these tablets should be dissolved in 5 cc. of distilled water. This tablet offers an opportunity to the anesthetist to prepare a Ringer solution for each injection. Distilled water, a little in excess of 5 cc., is placed in a dissolving cup and boiled down to 5 cc. One Ringer tablet B is then added. This will give the proper vehicle and is used to prepare the desired quantity of anesthetic solution.

CHAPTER X.

PREPARATION OF THE ANESTHETIC SOLUTION.

Procaine, the most nearly ideal local anesthetic so far developed, is offered to the profession by the manufacturers in the following forms:—Powder, prepared solution, ampules and tablets.

Procaine Powder.

The use of procaine powder in preparing the solution is not very convenient. It is necessary to weigh carefully the quantity of procaine used in the preparation of the solution. There is also the ever present danger of preparing a too strong or too weak solution. The greatest difficulty, however, lies in the addition of the proper amount of supranol and the prevention of its rapid oxidation. To make a 2% procaine solution, dissolve 9.6 grains of procaine to each ounce of Ringer solution. When the supranol is added, care should be taken to render the solution slightly acid to prevent its oxidation. About one hundredth of one per cent (0.01%) of chemically pure hydrochloric acid may be used for this purpose.

Dr. Herman Prinz advocates the addition of 2 drops of a 1:1000 stock adrenalin or supranol solution to each syringeful of 2% procaine anesthetic.

Prepared Anesthetics.

Prepared stock solutions sold by manufacturers should not be used, unless they may be sterilized again just before using. Although the preparation may be sterile when it leaves the laboratories, there is a possibility of contamination and infection on opening the bottle. An anesthetic solution containing very strong antiseptics or germicides, to prevent infection, should not be used, for if they are present in strong enough concentration to kill bacteria, they will also kill the delicate tissue cells. This will result in death of tissue, necrosis, subsequent infection and pain.

The prepared stock anesthetic solution should not be combined with the supranol. This should be either supplied in the form of tablets or else should be added by the operator from a stock supranol solution to each syringeful of the anesthetic. The addition of supranol to the stock bottle of the anesthetic solution makes the preparation of questionable stability on account of the tendency of the supranol to oxidation. Solutions of procaine without supranol are stable and will keep almost indefinitely.

The prepared anesthetic solution must be sterilized by heat, otherwise it should not be used. It should be boiled just before using and then the required quantity of supranol added.

An anesthetic of the desired type is now being marketed. The solution consists of procaine, Ringer ingredients and chlorbutanol. The supranol is supplied in tablet form, 1/360 gr. of supranol to each tablet. Before injecting, the solution is placed in a dissolving cup, boiled and then the supranol tablet is added in order to complete the anesthetic solution.

Ampules. Ampules containing the necessary ingredients for local anesthesia are obtainable on the market in various sizes and strengths. They may be used for injection, provided the operator is assured of their sterility. One must take the manufacturer's assurance as to that, for there is no opportunity offered to the anesthetist to sterilize the contents of the ampule before using. For this reason mainly, the writer's preference is for tablets or else an anesthetic solution, which he may sterilize again before attempting to inject it into the human tissues.

Tablets. The writer has been using the procaine tablets marketed under the trade name of Novol, and therefore is more familiar with the technique of the preparation of the solutions from these tablets. The following formulæ, numbered, are offered to the profession:

Procaine Tablets "No. 1" (dental), corresponding to "E."
  Procaine 0.02 gram (1/3 gr.)
  Supranol (epinephrin) 0.000045 gram (1/1500 gr.)
  1 tablet dissolved in 16 minims (1 cc.) of physiological salt or Ringer solution will give a 2% solution.
Procaine Tablets "No. 2," corresponding to "T."
  Procaine 0.02 gram (1/3 gr.)
  Supranol (epinephrin) 0.00002 gram (1/3300 gr.)
  1 tablet dissolved in 16 minims (1 cc.) of physiological salt or Ringer solution will give a 2% solution.
Procaine Tablets "No. 3," corresponding to "B."
  Procaine 0.1 gram (1½ gr.)
  Supranol (epinephrin) 0.000225 gram (1/300 gr.)
  1 tablet dissolved in 160 minims (10 cc.) of physiological salt or Ringer solution will give a 1% solution.

Procaine Tablets "No. 4," corresponding to "F."
Procaine 0.05 gram (¾ gr.)
1 tablet dissolved in 40 minims (2.5 cc.) of physiological salt or Ringer solution will give a 2% solution.

Procaine Tablets "No. 5," corresponding to "C."
Procaine 0.05 gram (¾ gr.)
Supranol (epinephrin) 0.000083 gram (1/800 gr.)
1 tablet dissolved in 40 minims (2.5 cc.) of physiological salt or Ringer solution will give a 2% solution.

Procaine Tablets "No. 6," corresponding to "A."
Procaine 0.125 gram (1⅞ gr.)
Supranol (epinephrin) 0.0000125 gram (1/533 gr.)
1 tablet dissolved in 160 minims (10 cc.) of physiological salt or Ringer solution will give a 1¼% solution, or
1 tablet dissolved in 80 minims (5 cc.) of physiological salt or Ringer solution will give a 2½% solution.

Procaine Tablets "No. 7."
(Suggested by Dr. John M. Scannell)

Procaine	0.16 gram (2⅖ gr.)
Sodium chlorid	0.15 gram (2¼ gr.)
Potassium chlorid	0.006 gram (9/100 gr.)
Calcium chlorid	0.012 gram (9/50 gr.)

1 tablet dissolved in 1 oz. of distilled water will give ½ of 1% isotonic procaine in Ringer solution.

Procaine Tablets "No. 8."
(Suggested by Dr. Buford Hancock)
Procaine 0.06 gram (1 gr.)
Supranol (epinephrin) 0.00006 gram (1/100 gr.)
1 tablet dissolved in 3 cc. physiological salt or Ringer solution will give a 2% solution.

Procaine Tablets "No. 9."
(Suggested by Dr. John M. Scannell)

Procaine	0.32 gram (4⅘ gr.)
Sodium chlorid	0.15 gram (2¼ gr.)
Potassium chlorid	0.006 gram (9/100 gr.)
Calcium chlorid	0.016 gram (9/50 gr.)

1 tablet dissolved in 1 oz. of distilled water will give 1% isotonic procaine in Ringer solution.

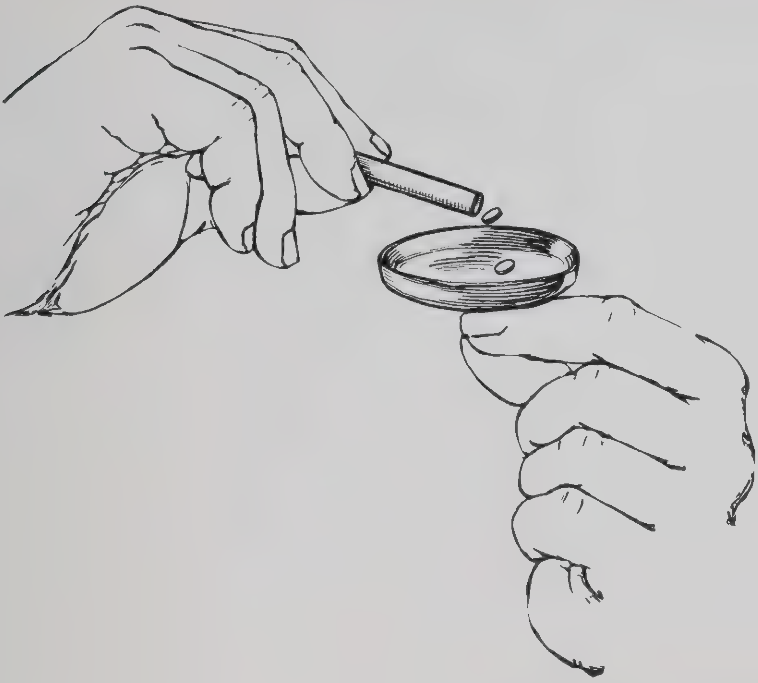


FIG. 174. Depositing the required number of tablets before placing them in the dissolving cup.

Procaine Tablets "No. 10."
  Procaine 0.02 gram (⅓ gr.)
  Supranol (epinephrin) 0.000045 gram ($\frac{1}{1500}$ gr.)
  Sodium chlorid to make a 2% isotonic solution.
  1 tablet dissolved in 1 cc. of sterile distilled water will give a 2% isotonic solution.
Procaine tablet for pressure anesthesia. (Pressure-Sthesia Billets.)
  Procaine 0.01 gram (⅙ gr.)
  Supranol (epinephrin) 0.00015 gram ($\frac{1}{440}$ gr.)

Preparing Solutions from Tablets.

In using procaine tablets, the isotonic vehicle must be prepared by the operator. To do this, three Ringer tablets A or six Ringer tablets B are dissolved in one ounce of distilled water. More than one ounce may be prepared at a time by using the proportionate number of tablets. The Ringer solution should be kept in a container made of non-alkaline glass, and so constructed as to prevent all possible contamination of the solution by dust and other foreign particles. A dropping bottle may be used or still better a Ringer flask. This flask is constructed of amber non-alkaline glass and is graduated up to four ounces. It has a ground-in stopper with a small perforation. The neck, also, has a perforation. In pouring out the solution the two perforations are approximated so as to facilitate pouring the liquid. (Fig. 181.)

When a patient presents himself for an extraction, the anesthetic solution is freshly prepared in the following manner: About 2½ cc. of the Ringer solution is poured into a porcelain dissolver and boiled over an alcohol or Bunsen burner flame. Two procaine tablets No. 1 or No. 2 are added to the solution in the dissolving cup and the solution is again brought to a boil. It is advisable not to prolong the second boiling because of the danger of oxidation of the supranol.

The tablets should not be handled by the fingers. A pair of sterile pliers may be utilized for this purpose. An easier and better method is to deposit the required number of tablets into the cover of the dissolver by gently revolving the tube and then placing these tablets in the dissolving dish. In this manner, if too many tablets should be expelled from the tube, the surplus may be returned to the container. (Fig. 174.)

The writer uses procaine tablets No. 1 almost exclusively, except in certain cases where it is desirable to reduce the supranol content. For instance, in very young or aged, in weak, anemic or arteriosclerotic patients; in patients suffering from disorders of the glands of internal secretions, particularly in exophthalmic goiter; in such cases the procaine tablets No. 2 should be used. These tablets have less than half the quantity of the supranol contained in tablet No. 1. Thus the rise in blood pressure, which is contraindicated in such cases, will not be so pronounced.

Procaine tablets No. 4 are used when the use of supranol is entirely contraindicated. The anesthesia, however, is rather weak in such cases and does not last. If the condition of the patient permits, a very minute quantity of supranol should be added from a stock supranol bottle in order to increase the strength and duration of the anesthesia.

Some operators prefer to combine one procaine tablet No. 1 with one procaine tablet No. 4, dissolving the two tablets in 2.5 cc. of Ringer solution to obtain a 2% solution in a comparatively weak supranol content.

Procaine tablets No. 5 are both economical and convenient. From one tablet, 2½ cc. of a 2% procaine solution may be prepared. The supranol content will be less than when an equal quantity of solution be prepared from procaine tablets No. 1 and more than when procaine tablets No. 2 are used. In a mandibular injection, one tablet will suffice not only for the injection at the sulcus but also for a long buccal injection should it be necessary.

Procaine tablets No. 3 and No. 6 are used in preparing for an extensive operation when larger quantities of the solution are desired. They are generally used by surgeons for work on the nose and throat and, also, for major operations.

Procaine tablets No. 7 are used by surgeons for major operations. These contain enough procaine to prepare an ounce of one-half of 1% procaine in Ringer solution. Thus a large quantity solution may be prepared conveniently. Sometimes as much as 10 ounces of solution are required for a laparotomy, hernia, thyrodectomy, etc. The supranol is added as such from a stock bottle just before the operation.

Similarly, procaine tablets No. 9 are used when 1% solution is desired instead of one-half of 1%. The Ringer ingredients are incorporated in the tablet and are calculated to render an isotonic medium when one tablet of No. 7 or No. 9 is dissolved in one ounce of distilled water.

Procaine tablets No. 8 were suggested by Dr. Buford Hancock. They contain three times the quantity of procaine and supranol as the procaine tablet No. 2. A 2% solution may be obtained by dissolving one tablet in a 3 cc. Ringer solution. Dr. Hancock prefers these tablets on account of their convenience in that a larger quantity of solution may be prepared from one tablet and also because they contain less supranol and therefore are less likely to give rise to disagreeable disturbances.

Procaine tablets No. 10 contain the same amount of procaine and supranol as the No. 1, but they have the sodium chlorid incorporated in their contents, thus obviating the necessity of using and preparing a Ringer solution. 2 cc. of distilled water are boiled in a dissolving cup and then two procaine tablets No. 10 are added to obtain a 2% isotonic solution. Each of these tablets may be dissolved only in 1 cc. of distilled water. Deviating from this quantity of distilled water to any appreciable extent will lead to hypotonic or hypertonic solutions.

CHAPTER XI.

ARMAMENTARIUM.

The instrumentarium of the anesthetist should be sufficiently complete to enable him to perform his work effectively and without undue delay; yet it should not be so cumbersome nor so plentiful as to impede his progress. All the anesthetic accessories should be made of porcelain, glass or metal and must be easily sterilizable at a moment's notice. The armamentarium should consist of syringes, needles, vehicle for the anesthetic solution and other accessories which we shall describe.

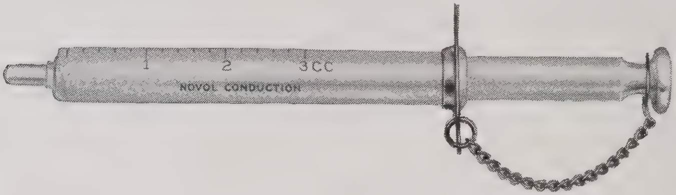


FIG. 175. Luer type syringe for nerve blocking injections.

Syringes.

The perfect syringe, for the dental surgeon, which will answer all his requirements, unfortunately has not as yet been designed. The ideal syringe must not be cumbersome, must not contain felt or fiber washers to disintegrate during sterilization; it must be taken apart easily for sterilizing purposes and be easily reassembled.

The all-glass Luer type syringe answers some of the requirements and may be used successfully in nerve blocking injections, but it has its disadvantages. It is too frail and cannot be used in infiltration injections or in other injections where pressure must be exerted to drive the solution into the tissues. In such cases the needle will often be forced off the hub during the injection. Luer type syringes are, however, very useful in extraoral injections. Pressure in such cases is uncalled for. The long needle may be inserted to the proper place and then attached to the syringe, previously filled with the anesthetic solution, and the injection made. The syringe, if necessary, may be refilled without removing the needle from the tissues. This is an obvious advantage. These all-glass syringes are used frequently by the dentist in the 2 cc., 3 cc. and 4 cc. capacities. (Fig. 175.)

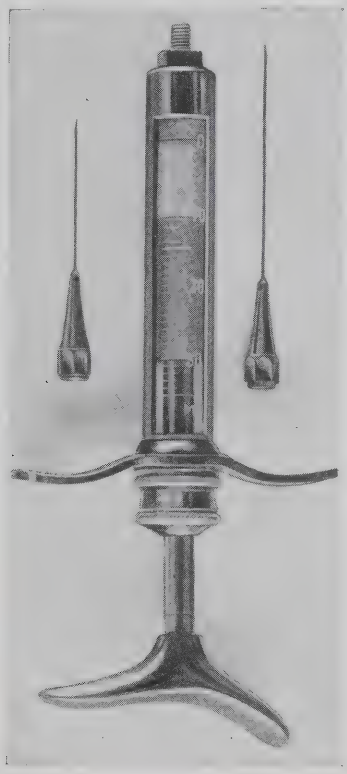


FIG. 176. A metal and glass syringe which may be used in both nerve blocking and infiltration injections.

A metal and glass syringe appears to be better adapted for general routine office work, inasmuch as it can be used for infiltration as well as conduction injections without the necessity of changing syringes. This type syringe is constructed of a metal frame holding a glass barrel. The metal plunger and needle-end-plug are ground in individually and are not interchangeable. This obviates the necessity of using washers. The barrel is graduated up to 2 cc. The syringe can be quickly taken apart for the purpose of sterilization and as quickly reassembled. It has its disadvantages in that the glass will break, as glass is prone to do, and, also, that after considerable use the friction of the metal plunger against the glass barrel will cause it to wear, resulting in a regurgitating syringe. In such cases a new barrel should be procured. These replacement units are obtainable from the manufacturers and supply houses. (Figs. 176 and 177.)

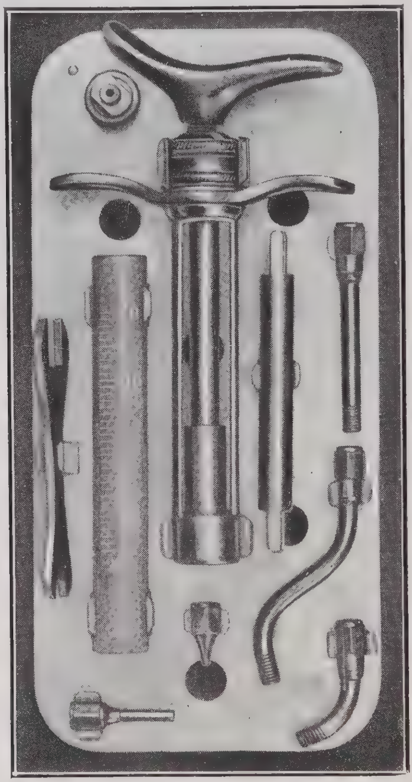


FIG. 177. Metal and glass syringe with all its parts and attachments adjusted to a metal plate, ready to be placed into the sterilizer.

An all-metal syringe, although stronger and more durable, gives but little satisfaction to the operator. Metal against metal wears rapidly, so that the syringe quickly becomes useless unless a packing is used. This, however, is not only an unclean procedure, but there is the ever-present danger of small particles of the packing being injected into the tissues together with the solution.

Needles.

A great array of needles of various sizes and gauges is contraindicated as it is conducive to confusion. The writer uses only two sizes of needles in his clinical work except when making a posterior infraorbital or an extraoral injection. One of these needles is 21 gauge 42 mm. long, of steel, or preferably iridio-platinum, for the mandibular, tuberosity and infraorbital injections, and the other is 23 gauge 25 mm. for infiltration anesthesia, posterior palatine and incisive injections. (Figs. 178 and 179.)

Preference is given, by the writer, to a steel needle soldered or swedged to the hub on account of convenience as well as strength.

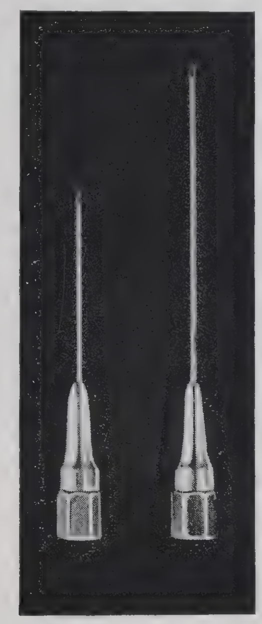


Fig. 178. Two hypodermic needles most frequently used in dental anesthesia, 42 mm. (1⅝") 21 gauge for mandibular, tuberosity and infraorbital injections and 25 mm. (1") 23 gauge for infiltration, posterior palatine and incisive injections.

A 21 gauge needle may appear to some to be entirely too heavy. Many operators voice their objection to this needle on the score of producing undue trauma and pain during its insertion. The writer's experience, however, teaches him that a 21 gauge needle will not produce any more pain or trauma than a lighter gauge needle, provided it has a sharp point. A needle may be compared to a lance. It is not the thickness of the blade that hurts, but the dullness of its edge. Similarly, it is the point of the needle that hurts and not its thickness. The writer inserted a 21 gauge needle into his own gum tissues at the reflection of the mucous membrane and, also, into the gums of a number of dentists with a view of determining the relative pain incident upon insertion of this heavy gauge needle with finer needles. The verdict unanimously was to the effect that there was hardly any perceptible difference.

The advantages in using the 21 gauge 42 mm. needle in all the nerve blocking injections are several. The thickness of the needle prevents breakage and renders it sufficiently rigid to enable the operator to find the desired location quickly without bending or distortion. A needle generally breaks at the hub, and as the average insertion is from 25 to 30 mm. there will be a sufficient length left protruding from the soft tissues to enable the operator to engage the needle with pliers and thus easily remove it. For this reason the entire length of the needle should never be inserted. If a ramus is unusually wide and there is a possibility that the entire length of the 42 mm. needle will have to be inserted in order to reach the mandibular sulcus, a 50 mm. 2-inch needle should be used. The necessity of using a needle of such a length is an exception rather than the rule. However, a few of these needles should be on hand always in case an occasion does arise.

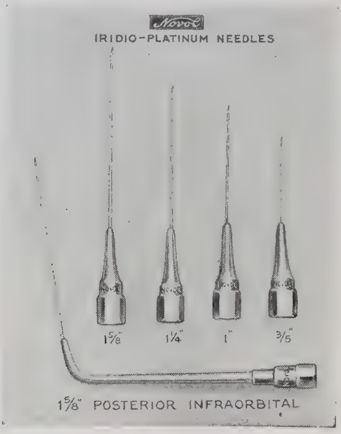


FIG. 179. Iridio-platinum needles used in conduction and infiltration injections.

The writer, many years ago, discarded the very short needles for infiltration injections, by the submucous or subperiosteal methods, and substituted a 25 mm. 1-inch length for this work. The short needles, like the longer ones, frequently break at the hub and may disappear entirely into the soft tissues. Frequently, it is difficult to recover these broken needles. Besides, the 25 mm. needle gives the operator an opportunity to reach the apical area beneath the periosteum without the necessity of several punctures.

In the posterior palatine injection the long 21 gauge 42 mm. needle is not indicated. This injection is made beneath the mucous membrane and into the underlying tough fibrous coat, which offers considerable resistance. A thick needle will, in this case, produce unnecessary trauma. The 25 mm. 23 gauge needle seems to be ideal for this injection. The same applies to the needle used for the incisive injection.

In posterior infraorbital injections the special 21 gauge 42 mm. needle mounted upon a right angle attachment should be used. (Fig. 90.)

In extraoral injections a 21 gauge 60 mm. needle is used.

A short $\frac{5}{16}''$ needle should be used in peridental and intraseptal injections only.

A 21 gauge 15 mm. needle, with a blunt point, is indicated in intraosseous injections. (Fig. 168.)

Sterilization and Care of Needles and Syringes.

The chain of aseptic precautions must remain unbroken in any form of local anesthesia, infiltration as well as nerve blocking. One broken link may nullify all precautions previously taken for sterility. It is not enough to sterilize only the solution. *All* the armamentarium must be surgically clean. This applies particularly to the syringes and needles used.

The syringe should be thoroughly sterilized in the morning before beginning the day's work. A glass and metal syringe must be taken apart before sterilization, placed in the sterilizer as separate parts and the water gradually brought to the boiling point. This precaution will save the operator many broken glass barrels, as the difference in degree of expansion, between metal and glass when subjected to heat, frequently causes the cracking of glass barrels.

The syringe may be sterilized in this manner before each operation. It is quite permissible, however, after the first sterilization, to wash out the barrel of the syringe with warm sterile water by drawing the water through the needle several times before using the syringe for subsequent injections. As only sterile solutions are used for injections, no opportunity is offered for carrying infection into the barrel of the syringe. Dr. Edmund C. Kells takes care of his syringe in the following manner, as described by himself:

> "While I have quite an assortment of syringes, the Fischer is the syringe of choice, and is used exclusively. The Fischer syringes will not stand boiling when assembled, but there is no necessity for boiling any syringe from day to day.
>
> "A new syringe must be taken apart, boiled (while wrapped in gauze) and then assembled in such a manner that the inside of the barrel and the plunger remain sterile, and then if nothing but sterile solutions are drawn into the syringe, it must always remain sterile.

"In order to prevent the outside of the barrel from coming in contact with the patient's lips or tongue, I proceed as follows:

"We obtain from the Seamless Rubber Co. of New Haven, Conn., what are known to the trade as standard rubber finger cots, pure gum (old No. 684) reinforced, small size. A hole is punched in the tip end of one of these cots by means of a rubber dam punch. A little talcum powder is dusted into it, whereupon it is slipped over the syringe and the trick is done. In this manner, no part of the barrel is ever contaminated by the patient's mouth.

"After use, the jacket is removed, boiled, dried and dusted with talcum powder. The whole syringe, hub and needle are then wiped off with gauze and seventy per cent alcohol."

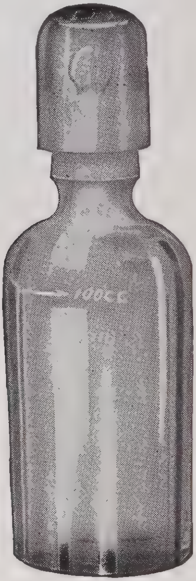


Fig. 180. Dropping bottle used for a stock physiological salt or Ringer solution.

While it is not quite essential to sterilize the syringe before each injection, the needle, however, must be sterilized before it is used each time. When a steel needle is used, it should be sterilized by boiling before its insertion. An iridio-platinum needle may be flamed.

After using, the needle should be thoroughly dried, a wire reinserted and then it should be put away in a proper receptacle. Needles should never be submerged and kept in a sterilizing solution, because of the formation of rust. A good method of preserving steel needles is the following: After its use, the needle is thoroughly dried. The lumen may be dried by a few blasts from the hot air syringe. The wire is then dipped into some essential oil (or even engine oil) and then placed in the lumen of the needle. Before using, the oil is removed by the boiling water during the process of sterilization. It will be found that this method will prolong the life of the steel needles as the lumen of the needle is more prone to rust than the outside. Steel needles should not be used for too long a time on account of the possibility of being weakened at some point by rust, due to frequent boiling.

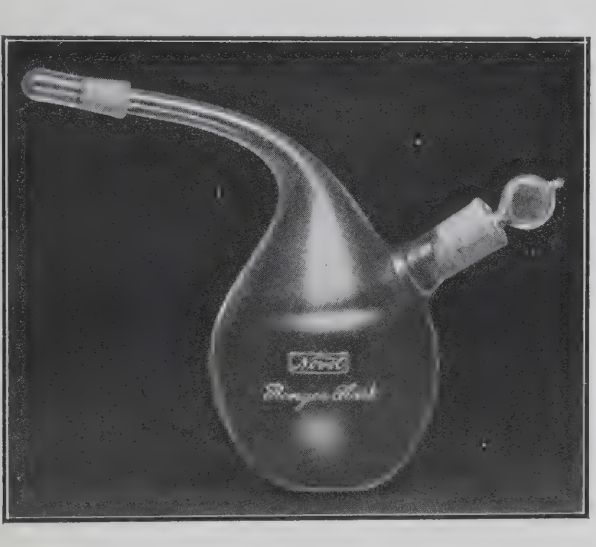


FIG. 181. Ringer flask of 4 oz. capacity, graduated, made of amber non-alkaline glass and having a ground-in glass stopper and cap.

Nickel needles are not prone to rust so easily but they are too pliable and they lack the rigidity of steel.

The needle point should be kept sharp always. A dull point produces considerable trauma and pain. Steel needles should be thrown away when their points become dull. Points on platinum needles may be resharpened, using very fine sandpaper or cuttle fish discs. A convenient and efficient method is to insert the needle into a cork so that the point projects very slightly above its surface. The needle point is then filed down and sharpened with a fine paper disc.

Armamentarium for Preparing the Solution.

Besides the syringes and needles, the anesthetist should supply himself with a proper container for his physiological salt or Ringer solution and a boiling cup.

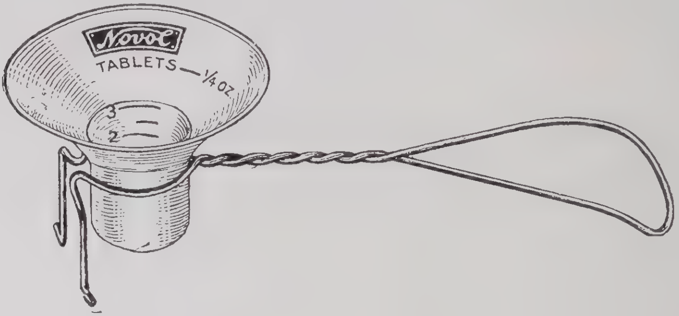


Fig. 182. Porcelain dissolver graduated up to 3 cc. for preparing the anesthetic solution.

The container for the stock Ringer solution should be so constructed as to eliminate all possible sources of contamination from dust or particles flying in the atmosphere. A dropping bottle (Fig. 180) will answer the purpose, but what is still better is a specially constructed flask. (Fig. 181.) The advantage of the flask is that it is made of non-alkaline glass, which prevents oxidation of the solution that may occur if kept in common glass bottles.

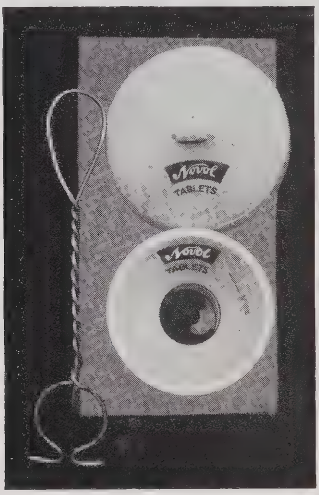


Fig. 183. Porcelain dissolving cup and cover to protect the solution from contamination.

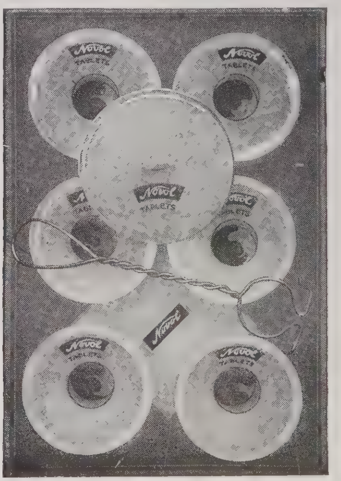


Fig. 184. A set of six dissolving cups.

For boiling the anesthetic solution a graduated test tube may be used. Porcelain boiling cups of various sizes are obtainable and are more desirable. Figs. 182, 183 and 184. They are made in 3, 5 and 10 cc. capacities. They are more convenient to handle and to keep clean. Fig. 185 shows an electrically operated device for boiling the solution. The current is connected by the contact of the ring, holding the cup, with the heating compartment. The solution boils in about one minute.

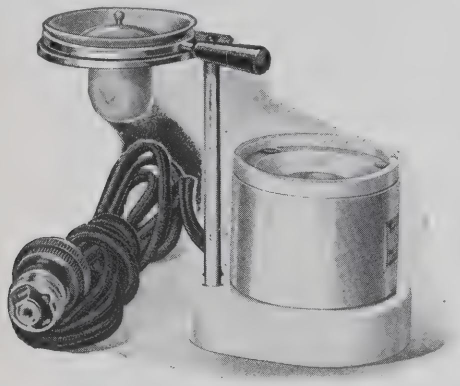


Fig. 185. Electrical appliance for dissolving the anesthetic tablets.

Fig. 186 represents a convenient stand for dissolving procaine tablets and sterilizing the needles. It obviates the necessity of holding the dissolver over the flame. The 10 cc. cup may be used for sterilizing the needles.

Fig. 187 represents a Kells' procaine unit, devised by Dr. C. Edmund Kells. Here is how Dr. Kells describes his method of preparing the anesthetic solution and using his unit:

> "To prepare the Ringer solution:
>
> "Partly fill the Ringer flask with freshly distilled water and shake it well so that every part of the inside of the flask is well reached, and then pour it out; thus the flask is rinsed.
>
> "Pour into the flask ten or fifteen mils of freshly distilled water. place it in the ring, adjust the cap over the spout loosely, swing over the lighted burner and bring to a boil. Let it boil for two or three minutes, grasp the flask by means of the handle and empty it. Thus is the flask sterilized.
>
> "Pour in thirty, sixty or ninety mils of freshly distilled water, as one requires, add the necessary number of Ringer tablets, place a tuft of sterile cotton in the inlet, swing over the burner and heat, but do not boil. Shaking the flask will hasten the dissolving

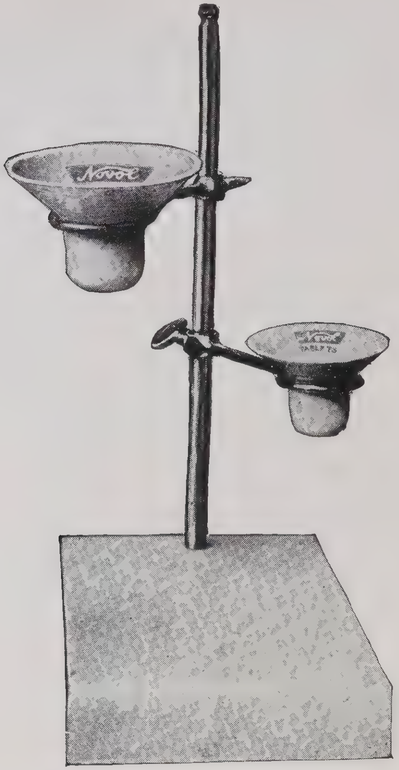

Novol
Novol
TABLETS

FIG. 186. Stand for dissolving cups.

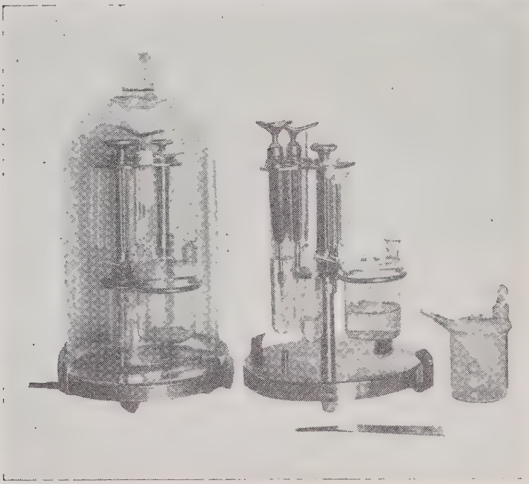


FIG. 187. Dr. Kells' procaine unit.

of the tablets. Thus has been made a perfectly isotonic Ringer solution.

"To prepare the procaine solution:

"Pour two or three mils—not more—of freshly distilled water into the dissolving tube, slide on the cover and allow to boil.

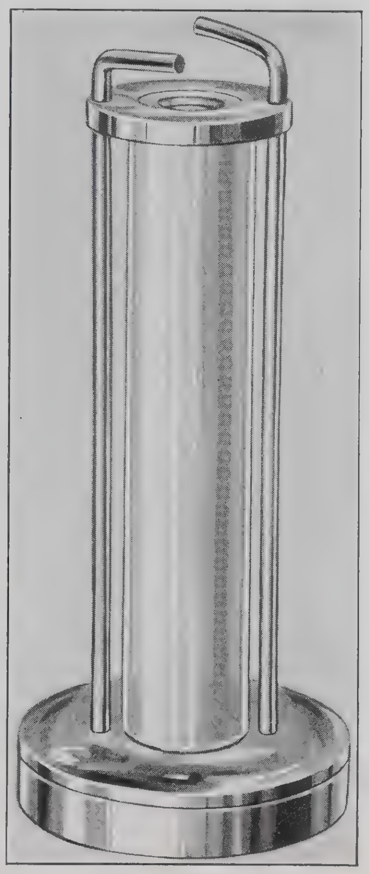


Fig. 188. Sterilizing stand for one hypodermic syringe.

This sterilizes both tube and cover. Swing away from burner and empty the tube by means of the syringe. Fill the syringe slowly. This rinses both tube and syringe.

"Pour in the exact quantity of Ringer. If, by accident, a little too much has been poured in, draw the excess out by means of the syringe. Drop in the required number of tablets. Take the wet stirring rod out of its tube and dry it thoroughly over the Bunsen flame. This sterilizes it. Swing the dissolving tube over the burner and warm only. Do not boil. Swing away. With the stirring rod, hasten the solution of the tablet and stir well, then wipe off the rod very thoroughly and replace in the tube. Thus is an isotonic solution prepared and should be injected at body temperature.

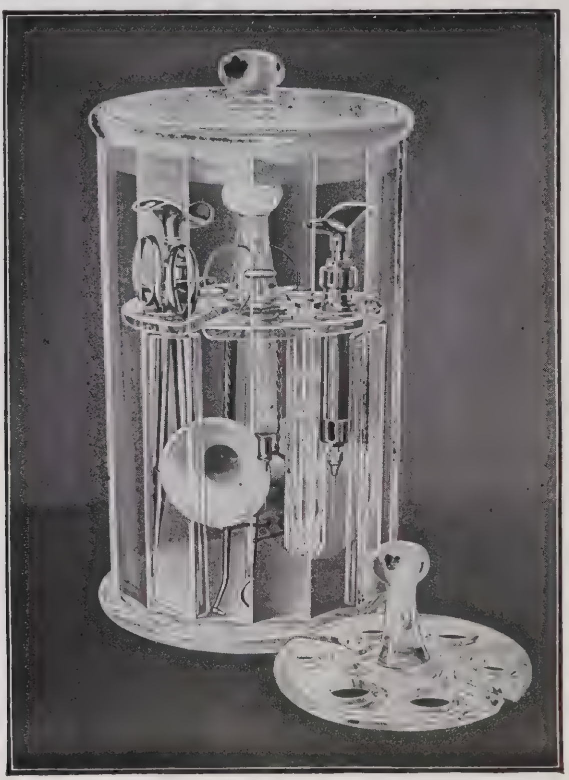


FIG. 189. Hood's complete sterilizing jar.

"After the operation:

"Fill the dissolving tube with distilled water and then pour it out. This rinses the tube. Pour in two or three mils—not more—of distilled water and bring to a boil; swing away; flame the platinum needle and empty the tube by means of the syringe. This rinses the syringe. Swing the cover over the tube."

Antiseptic Solutions.

The writer prefers to keep his needles and syringes, when not in use, in a glass or other suitable container, not submerged in antiseptics, and to sterilize them just before using. The alcohol and glycerin solution will rust the needles and it is doubtful whether their sterilizing properties are to be fully relied on to render the syringe and needle absolutely sterile. Care must be taken that all traces of alcohol are carefully removed from the syringe and needle before attempting to make an injection, as alcohol may cause an undue prolongation of anesthesia.

A better sterilizing solution for this purpose would be as follows:

Carbolic acid	30 cc.
Bicarbonate of soda	15 gr.
Glycerin	300 cc.
Aqua Rosa	200 cc.
Distilled water	1500 cc.

The percentage of glycerin may vary in order to make the solution more or less lubricating. The solution should be filtered before using. This solution will not cause the instruments to rust as readily as the 70% alcohol and 30% glycerin combination and will be found to be more economical. Fig. 188 represents a stand for sterilizing solution to accommodate one syringe. Fig. 189 is a complete sterilizing jar accommodating several syringes, needles, dissolving cups and other instruments.

CHAPTER XII.

POSTINJECTION AND POSTOPERATIVE SEQUELAE.

With the advent and adoption of nerve blocking, there came an increase in postinjection complications. Not because these are necessary aftermaths of conduction anesthesia, but rather because of lack of care and asepsis and, especially, lack of proper understanding of the surrounding anatomical structures, resulting in faulty technique. In discussing this very important subject, we must discount the normal pain following any surgical interference; pain as a normal physiological manifestation due to the severance of tissue and exposure of the severed afferent sensory nerve filament to stimulation and irritation; also pain due to the engorgement of the operative area with blood as a protective measure by nature to combat any threatened bacterial invasion. Such reactions are normal and should be expected. Pain lasting for several hours following the operation is not an abnormal occurrence, although with proper postoperative treatment instituted, this pain may be reduced to the minimum. But the prolonged pain, swelling and other complications are not at all necessary and can be avoided to an appreciable extent.

The following are the most frequent postinjection and postoperative complications:

(1) Prolonged pain either at the seat of operation or injection.
(2) Temporary or false ankylosis.
(3) Edema.
(4) Toxic disturbances such as perspiration, trepidation, pallor and fainting.
(5) Prolonged anesthesia.
(6) Facial paralysis.

Let us take these up one by one.

Prolonged Pain. Prolonged pain following the injection and operation may be due to one of several of the following causes:

(a) Infection.
(b) Injection into a muscle.
(c) Trauma.
(d) Injection of non-isotonic and irritating solutions.

Infection.

It is quite obvious that sloughing, necrosis and pain will follow infection. This is true in all types of local anesthesia and is not any more pronounced in nerve blocking than in infiltration, except that perhaps it is more annoying and harder to combat. The solution, the needles, the syringe, and the mucosa at the point of insertion must be rendered sterile. Extreme care must be taken to maintain the entire chain of asepsis unbroken. A sense of surgical cleanliness must be developed by diligent and persevering application to details in maintaining asepsis. This is important, and no one should attempt local anesthesia unless one is painstaking in this regard. It is quite true that many thousands of operations in the oral cavity are being performed without strict asepsis and yet without any postoperative complications. This must be due to the inhibitory action of the salivary secretions toward infection. But there are also many cases on record where oral surgery of that type resulted in many serious sequelæ and even death. If we only knew when infection will follow and when it will not, we could take the necessary precautions in these few cases, but not knowing when it will come, care must be taken in *every* case of surgical operation in the oral cavity, no matter how slight its nature may be.

In the chapter on armamentarium, the method of sterilization of the syringe, needles, etc., has been described. The best method of preparing the site of the initial puncture is to paint it with 7% tincture of iodin or one part of tincture of iodin and two parts of acetone. This hardens the mucosa and inhibits the growth of bacteria.

Very often the operator may reinfect his needle before its insertion by getting it in contact with the patient's lips or tongue. This should be carefully avoided. If it becomes necessary to change needles, the removed needle should be sterilized again before using or it should be placed in a piece of sterile gauze until it is picked up again. A platinum needle may be, of course, easily resterilized by flaming.

Injection into a Muscle.

Injection into a muscle will often result in pain which may persist for several hours or several days. Absorption of the solution in muscle tissue is very tardy and the presence of the foreign matter often results in pain. In previous chapters we have discussed the possibility of entering muscles in the various injections, namely the internal pterygoid in a mandibular injection, the external pterygoid in a tuberosity and the caninus in an infraorbital. The technique to be followed in each injection with a view to avoiding these muscles has been fully described.

Trauma. It is understood that trauma will be followed by pain. Trauma may be produced by the operation as well as by the injection. All unnecessary lacerations and tearing of tissues should be carefully avoided. The operator should learn the use of elevators in conjunction with his forceps for the removal of teeth. Deeply embedded roots cannot be removed by the use of forceps, but will easily lend themselves to relief when the proper elevators are employed. If necessary, the process should be chiseled away in a surgical manner and not simply crushed between the beaks of a forcep. The ruthless destruction of tissue results in death of tissue, sloughing, necrosis and pain, persisting very often for days and even for weeks.

Trauma and consequent pain may be produced by the injection itself. When the needle is inserted too many times, when it unnecessarily penetrates muscle, when it strikes the periosteum too often and too forcibly, the result is only too frequently traumatic injury. The site of the original insertion of the needle should be predetermined and then the needle inserted into the tissue firmly but gently. The injection is then made just as firmly and gently. Repeated punctures of the needle, sometimes from a sense of compassion for the patient, reminds the writer of the story of the boy who, for the love of his dog, could not bring himself to amputate his friend's tail at one operation, but would cut off a small piece every day until the desired length was removed.

Trauma and pain may be caused by too rapid injection of the anesthetizing solution. Not only does toxicity increase with the rapidity of the injection, but the delicate tissue cells are unable to accommodate themselves to the too rapid distension and injury is often the result. Slow injection of the solution gives the cells sufficient time to adjust themselves to their new surroundings without interference with their normal physiological function. A rule should be established to take about one minute for the injection of a 2 cc. syringeful.

Again tissues may be traumatized following the operation by too tight or too numerous sutures, too tight dressings and many other factors which may stimulate the severed afferent sensory filaments, carrying the uncomfortable sensation to the pain center. As few ligatures or sutures should be used as possible, care being taken not to compress the incised edges too strongly.

Irritating Solutions.

The injection of irritating solutions is a very frequent cause of postinjection pain. The anesthetic solution should not contain any strong antiseptics, germicides, preservatives or any other ingredients which may tend to irritate the tissue cells or to interfere with the granulation process. The theory of loading the solution with germicides to prevent subsequent infection was exploded a long time ago, and only leads to defeat the very purpose for which the germicides are intended. If the germicides are present in concentration strong enough to kill bacteria, the tissue cells will be destroyed as well. Death of tissue will thus ensue; then necrosis, sloughing, infection and pain. The modern tendency is to avoid germicides and strong antiseptics in treatment of wounds and to rely upon the leukocytes to combat infection. The use of germicides in a local anesthetic in order to protect the tissues from bacteria may be compared to the bear in Æsop's fable which tried to protect its sleeping master from a fly by killing it with a large stone. The anesthetizing solution should contain only the anesthetic base, dissolved in a Ringer or normal salt solution with the necessary strength of supranol. Chlorbutanol, not exceeding ½ of 1% is permissible. The addition of this drug tends to enhance the anesthetic effect, inhibits (does not kill) the growth of bacteria, and also acts as a hypnotic.

The importance of having an isotonic solution has been dealt with in a previous chapter. This will prevent any interference with the normal cell metabolism and their normal physiological function. Hypertonic solutions, in particular, will tend toward breaking down of tissue cells and postinjection pain. Strongly hypotonic solutions will interfere with healing, but not to the same degree.

Temporary or False Ankylosis.

This frequent postinjection and postoperative complication has been already gone into in the chapters dealing with the technique of the various injections. As a postinjection sequela it more often follows a mandibular injection than any other. The internal pterygoid and also the masseter muscles may be entered, traumatized and the solution injected therein. This results in edema and also in loss of normal muscle function. namely relaxation and contraction. These facts contribute toward the inability of the patient to open his mouth following the injection. For detailed description of this condition, the student is referred to the chapter on pterygomandibular anesthesia.

Fortunately, this condition does not persist long and the normal function of the muscles is restored in a few hours or at the longest a few days. It is, however, unpleasant both to the operator and patient, and every possible endeavor should be made to avoid it by carefully following the correct technique.

Temporary loss of movement of the mandible may be due to the operation itself. The trauma created by the removal of impacted wisdom teeth may produce a condition known as trismus, in which the inflammation progresses to the surrounding structures infiltrating the superior constrictor of the pharynx, the internal pterygoid and other muscles of mastication. This condition varies in its degrees of severity from partial to complete closure of the jaws.

Edema and Ecchymosis.

The anesthetic solution when injected directly into a muscle will remain there without absorption for a considerable time, producing edema and swelling. Thus, injection into the internal pterygoid and masseter muscles in a mandibular injection; into the external pterygoid in a tuberosity injection; or into the caninus in an infraorbital injection, may produce this condition. How to avoid these muscles was discussed in detail in description of the technique of these injections.

Another fruitful cause for large swelling is entrance into the pterygoid plexus of veins, causing a profuse exudation of venous blood. This is apt to occur in a tuberosity injection. Knowing the anatomical location of this plexus, the anesthetist can easily avoid it by endeavoring to have the needle in close proximity to the tuberosity of the superior maxilla.

Discoloration or ecchymosis is due to exudation of venous blood and blood stasis. This follows the entrance of the needle into a vein, which causes a venous exudation, or else by entering into a muscle and creating traumatic inflammation. More blood then is brought to the inflammatory area to combat threatened infection. The engorged blood vessels impede the free flow of blood.

Ecchymosis more frequently follows an infraorbital injection than any other and to the writer's mind must be due to entering the caninus muscle by passing the needle too close to the floor of the canine fossa. Ecchymosis will occur even in cases where no local injection has been employed at all. These cases are only due to trauma incident upon the operation. Inflammation, blood exudation, blood stasis and finally return to normal by the absorption of the exudates, are the steps taking place in these conditions.

Toxic Disturbances.

Toxic manifestations do appear in local anesthesia. Procaine is the safest efficient local anesthetic so far discovered, yet it should be remembered that some patients possess a peculiar idiosyncrasy toward this drug. Procaine is acceded by many to be anywhere from five to seven times less toxic than cocaine. The writer has used procaine for many years and in many cases, and failed to observe any really alarming symptoms following its use. Often as much as 20 cc. of 2% procaine solution have been used without any apparent effects upon the patient. One case is particularly vivid in the writer's memory. A dentist from Australia was anxious to see all the various injections and came to the writer for this purpose, while travelling in the United States. A patient requiring a good deal of dental attention was selected, and all the nerve blocking injections were performed. These injections required the use of a full tube of twenty procaine tablets No. 1, which meant the use of nearly seven grains of procaine at one sitting. The patient appeared to thrive on it.

The writer has had the opportunity to watch some prominent surgeons perform major operations under procaine anesthesia, such as laparotomies, thyrodectomies, hernia, etc. As much as ten ounces of a ½ of 1% procaine solution has been frequently used in such operations without giving much thought to the patient. This is because the surgeon in operating has a full view of the operative field. In injecting the various strata such as the skin, the subcutaneous tissue, etc., and then incising them, the operator can easily avoid entering the blood stream and thereby prevent one of the most fruitful causes of toxicity. The dental surgeon's field of operation is, however, entirely different and is fraught with difficulties. First, he must contend with bony structures and not soft tissues, and secondly, the oral cavity and surrounding structures upon which the dentist operates are highly vascular. It is, therefore, a comparatively easy matter for the dentist to enter into some more or less important vein or into some one of the numerous smaller tributaries and thus deposit the anesthetic solution intravenously, thereby greatly increasing the toxicity of the anesthetic.

Here are the three main causes for the toxic manifestations following the use of procaine or any other local anesthetic:

(1) Injecting into the blood stream.
(2) Too rapid injection.
(3) Upright position of the patient during the injection.

Injecting into the Blood Stream.

By injecting various anesthetics at first subcutaneously, then intravenously and intraärterially and carefully observing the effects, it has been determined that the toxicity of the anesthetic will increase, when injected intraärterially, about four times in comparison with the injection of the same quantity of the drug subcutaneously; and when injected intravenously, the ratio of the increase in toxicity will be one to sixteen times. In other words, the lethal dose of the anesthetic in a subcutaneous injection is four times as large as in an intraärterial injection and sixteen times as large as in an intravenous injection. This is undoubtedly due to the fact that the arterial blood current flows away from the heart toward the periphery while the opposite is true in the venous circulation. The toxic effect of the drug is spent itself upon the tissue cells in a subcutaneous injection and thus weakened, is gradually being absorbed and slowly liberated into the circulation without any toxic disturbances. In the injection into a blood vessel the entire solution is immediately taken up by the general circulation without leaving the lumen of the vessels and is thus carried either to the heart or the brain centers, often producing serious toxic results.

It is much easier to enter a vein than an artery. The tough slippery muscle coat of an artery protects it from the penetration by the needle; the flabby wall of a vein, however, does not offer any serious resistance.

Aspiration.

A simple method of determining whether a vein has been entered or not is the following: When the needle is in position and just before injecting the solution, pull the plunger slightly back. If a blood vessel has been entered, the blood will rush into the syringe. The point of the needle is then slightly withdrawn and placed in a different position and again tested. If a vacuum should be formed in the syringe, it would be an indication that the needle is not in a blood vessel and the solution may then be slowly injected. As the needle has not been entirely withdrawn from the tissues, both the solution and needle remain sterile. This test when made in every nerve blocking injection, before the solution is discharged from the syringe, will serve to eliminate a great many toxic disturbances.

Slow Injections.

It has been determined by experimentation upon animals that the toxicity of an anesthetic increases in proportion to the rapidity of the injection. Both infiltration and nerve blocking injections should, therefore, be made very slowly. The anesthetist should make it a general rule to take at least one minute for the injection of a 2 cc. syringeful of a 2% procaine solution. Not only will this procedure prevent the development of toxic manifestations, but it will also prevent traumatization of the tissue cells with which the injected solution comes in contact.

The following clinical case has a distinct bearing upon the rapidity of the injection:

A patient, a man of about forty, was given a mandibular injection on the right side, the solution being quickly forced into the tissues. About 2 cc. of a 2% solution was used. Toxic symptoms appeared almost immediately, such as pallor, profuse perspiration, trepidation and fainting. The patient was quickly restored by the administration of about 10 drops of validol. As good anesthesia was established, several lower teeth on the anesthetized side were removed without any discomfort to the patient. The patient then insisted that some roots on the left side of the mandible and also in the upper jaw be removed. Another mandibular, an infraorbital, tuberosity, anterior and posterior palatine injections were given, using an additional 8 cc. of a 2% procaine solution. This time, however, the solution was injected very slowly, and the patient did not exhibit any signs of toxicity whatsoever.

Position of Patient During Injection.

While injecting, the patient should be placed in a comfortable semi-reclining position. The dental chair should be adjusted at an angle of about 45°. After the injection the chair may be brought to any desired position. Injections should not be made with the patient in an upright position. The effect of procaine is not cumulative. Once the drug has entered the circulation, it is carried to the liver and there broken up, becoming inert. Animals, injected with a lethal dose of procaine resulting in a complete suspension of respiratory and cardiac action, were resuscitated by direct heart stimulation.

The blood rushing to the liver by portal vein carries the procaine with it, where it is broken up and no longer exerts any toxic influences upon the circulation. The semi-reclining position places no extra strain upon the heart, but on the contrary, carries it through the critical moments in assisting the circulation and sending the blood current forward to the liver.

Dr. Emil Mayer in his report of the committee on the advantages and disadvantages of various local anesthetics in nose and throat work, which appeared in the *Journal of the American Medical Association,* October 22, 1921, gives twenty-seven fatalities from the use of local anesthetics; three of these could be attributed to the use of procaine. In nineteen of these cases the injections were made in an upright position, and only on three patients in a reclining or semi-reclining. The inference is drawn from this report that the reclining position of the patient is to be preferred, in that the strain upon the heart is thus relieved, carrying the patient through those critical moments during which the toxic effect of the poison manifests itself.

These three precautions, when taken, namely: testing the syringe to determine whether the needle is in a blood vessel, injecting the solution very slowly, and placing the patient in a comfortable reclining position, will materially help to reduce shock and toxic disturbances to a minimum.

Prolonged Anesthesia.

This condition occurs more frequently as an aftermath of the operation than the injection itself.

Care must be taken that all traces of alcohol be removed from the needle and syringe and also the solution, as alcohol tends to unduly prolong the anesthesia.

Loss of sensation to the tongue and lip for any length of time is primarily due to the operation itself. It must be remembered that the lingual nerve runs near the apices of the last two molar teeth on its way to innervate the lingual mucous membrane of the lower teeth and the anterior two-thirds of the tongue. The removal of the wisdom tooth in particular may cause some injury or severance of the lingual nerve. The result will be loss of sensation to the tongue on the same side. Similarly, the mandibular canal containing the inferior dental nerve may sometimes run perilously near the apices of the lower molar teeth. The infected area may sometimes progress and involve the mandibular canal, or else the mandibular canal may be entered during the removal of the offending molar or else during the process of curetting the socket. The inferior dental nerve in such cases may be severed and thus produce anesthesia of the area it supplies distally from its point of injury. Loss of sensation to the buccal mucous membrane of the bicuspid and anterior teeth and the lip on the side of the injury will take place.

The mental nerve may frequently be injured during the removal of the lower bicuspid teeth, especially in impaction of these teeth. In such cases the lip on that side only will be affected.

In the maxilla, prolonged anesthesia does not occur as frequently as it does in the mandible. This condition in the maxilla is due chiefly to the injection itself or to injury of the nerve by the point of the needle than to operative interference. The removal of the upper teeth cannot affect the infraorbital nerve.

There are several cases on record where an injury to the infraorbital nerve from an injection resulted in anesthesia of the upper lip for a considerable length of time until regeneration took place.

The prognosis in all such cases is favorable. Sensation will gradually return; the time required for complete restoration of sensation will depend largely upon the injury to the nerves. The anesthesia may last anywhere from a few weeks to a year or longer. When regeneration of the nerve tissue is complete, full sensation is restored. While sensation is gradually coming back, there may be a peculiar tingling sensation in the lip, in the lower jaw, which condition may persist until complete recovery.

There is really very little that can be done for the patient in such cases, except to wait until regeneration of nerve tissues takes place. Perhaps massage and electrical vibration may stimulate regeneration, but this is problematical.

Facial Paralysis.

Permanent facial paralysis is not an aftermath of a nerve blocking injection. This condition follows some severe injury to the facial nerve blocking the efferent conductivity to the muscles of expression. Temporary facial paralysis frequently follows conduction anesthesia. This is especially true in the pterygomandibular injections. The student must again be referred to the description of the technique of this injection and especially to Fig. 130, which graphically shows how the needle, when advanced too far in a mandibular injection, will enter the parotid gland and may anesthetize either the entire facial nerve or one of its branches. The result will be relaxation of the muscles of the face on the affected side, the extent depending entirely upon the area which the blocked branch of the facial nerve supplies. Should the entire facial nerve be reached by the anesthetic solution, all the muscles of that side of the face will be affected. There will be a drooping of the lips and eyelids.

This condition, just like temporary ankylosis, does not as a rule last long and only persists as long as the action of the solution is exerted upon the motor nerves. The temporary facial paralysis passes away in a few hours. In most cases it may be prolonged for a day or two. But while it lasts, this condition is annoying both to patient as well as to operator.

Temporary facial paralysis does not follow a tuberosity injection. An infraorbital injection, however, especially when correctly performed, very often produces a marked drooping of upper lid on the side of the injection. This is due, as explained in a previous chapter, to the anesthetization of the infraorbital plexus and consequently the terminal branch of the cervicotemporal branch of the facial nerve which supplies the upper lip.

CHAPTER XIII.

PREOPERATIVE AND POSTOPERATIVE TREATMENT OF THE PATIENT.

The writer heard an essayist at a dental meeting classify all patients into two groups. First class, nervous. Second class, very nervous. This division, although uttered in a humorous vein, struck him as very characteristic. As dentists, hardened to our task in the daily routine of our work, we may forget the patient sometimes, who, to us, often ceases to be a human being with a complex nervous system but who becomes a typodont upon which teeth are to be removed, filled, ground or restored. We lose sight of the fact that it may have taken a great deal of courage and strength for the patient to finally come to us for that particular operation. The dread of the impending ordeal is, to some patients, excruciating and deserves the deepest sympathy on the part of the operator. Some patients will show it less than others, but all approach the dental chair with more or less dread and trepidation.

It is not a bad idea for the dentist to place himself in the patient's position once in a while, so that he can be more sympathetic with his patients.

Some time ago the writer suffered from a peritonsillar abscess. This affection is unusually distressing and painful. It was necessary to lance the abscess. This was done without any anesthetic. The pain, although excruciating and intense, was but momentary, but the shock to the nervous system was terrific and persisted for many hours after the incision. It was found that the opening was not large enough to drain the abscess and so the operation had to be repeated twice, subsequently, to establish satisfactory drainage. The anxious moments of waiting in the ante-room, the preparations for the operation, the actual operation itself, all worked havoc with the writer's nervous system and were too excruciating to permit a vivid description. Why the rhinologist insisted upon operating without any anesthetic or some means of alleviating the pain still remains a mystery to the writer. Remonstrations were out of the question as the power of speech was temporarily lost due to the swelling. At any rate, the writer's behavior was such that he could be regarded as a good patient, perhaps, and undoubtedly should be catalogued in the first class of patients, namely nervous.

Since then, the writer's attitude toward his patients has changed somewhat inasmuch as he can feel for them. They cease to be typodonts, but are beings endowed with as much feeling as the operator himself.

A word of sympathy uttered at the proper time, thoughtfulness for the comfort of the patient, assurance that you will do all in your power to make the operation as painless as possible, will not only allay the fears of your patient, but will make his and your task much easier, and will assure you of an appreciative patient.

Preoperative Treatment.

Some patients, particularly those of the second class, are beyond the power of moral persuasion. Their nervous system is too wrought up. For such patients, a sedative is indicated. In administering a sedative, however, care should be exercised in its selection. The coal tar derivatives are often too depressive to be of real value to the dental surgeon. The three bromides may be administered, but their action is rather light. Of the three bromides the sodium is used in preference to the potassium and ammonium. The three may be given together incorporated in one tablet.

A far safer and better nerve sedative is bromural, given about 20 minutes before the operation. One five-grain tablet will suffice, but two may be given, if necessary.

Bromural is a white powder. For convenience of administration it is also marketed in 5 gr. tablets. The chemical name of bromural is alpha-monobrom-isovaleryl-urea and may be expressed by the following chemical formula: $(CH_3CH(CH_3)(CH\ BrCO)\ HN\ CO\ NH_2$. Bromural is not readily soluble in cold water but is easily soluble in hot water, ether, alcohol and alkalis. Bromural is an ideal nerve sedative and mild hypnotic. Its action is more marked than that of the bromides, and yet, unlike the bromides, it is free from any depressing effects. It is claimed that the circulation and respiration are not affected by the use of bromural, and its action ceases in from three to five hours after administration.

When a nervous, hysterical or apprehensive patient has to be dealt with, it is a good idea to give the patient one or two 5 gr. bromural tablets about 20 minutes or a half hour before induction of anesthesia. The irritability of the central nervous system will be allayed, and the patient will be more susceptible to the anesthetic. It also relieves the anxiety, restlessness and psychic effect of the impending operation.

Other drugs that may be used as sedatives are chloral hydrate and morphine. These are not entirely safe, however, and should be seldom employed. Chloral hydrate is a heart depressor, while the ever present danger of addiction should restrain every practitioner from administering even very small doses of morphine.

Another drug of value to the dental surgeon is validol. This is a liquid, known chemically as menthyl-ester of valeric acid with 30% free menthol. It may be expressed by the following chemical formula: $CH_3 (CH_2)_3 COO C_{10}H_{19}$. Validol, also, has marked sedative and anodyne properties and it is for that reason indicated in nervous and hypersensitive patients. About ten drops of validol may be given to the patient in a little water or on a piece of sugar, as suggested by Dr. Edmund C. Kells.

The camphorated variety of validol is a solution of 10% camphor in validol. Beside sedative properties, camphorated validol exerts a stimulating effect upon the patient by virtue of the camphor content. Thus, the sedative action of validol combined with the stimulating effect of camphor makes this drug very valuable to dental surgeons as a restorative in case of toxic manifestations, syncope, sudden cardiac failure, etc. The heart is directly stimulated without any effect on the brain centers. Ten drops will quickly restore the patient. It should be given internally. In cases where the patient is unable to swallow, it may be dropped under the tongue or injected hypodermatically.

Validol is said to be an efficient antemetic, and is therefore administered in nausea and vomiting, particularly when due to nervousness or the administration of anesthetics.

Postoperative Treatment.

But the responsibility of the operator does not cease with performing the operation painlessly and dismissing the patient. Postoperative treatment should be immediately instituted to assure the patient's comfort during the few critical hours following the operation. The nervous strain and nervous exhaustion of the patient should be taken into consideration.

The wound should be left in a receptive condition for the formation of a healthy blood clot and rapid granulation. All spiculæ of bone should be carefully removed, rough edges of the alveolar process should be trimmed and the socket, if pain is anticipated, should be packed with novesthene powder or a paste made of novesthene, and procaine with lanolin or vaseline. Also, a saturated solution of novesthene and procaine in essential oils may be employed successfully.

Novesthene, or anesthesin, has been described in the chapters dealing with the pharmacology of drugs used in local anesthesia. This local anesthetic led finally to the discovery of procaine. Novesthene has marked anesthetic properties, but being insoluble in water, it naturally cannot be used hypodermatically. This property, however, makes it valuable as a local anesthetic for topical applications in wounds, in alveoli after the removal of teeth or on any broken and injured surface. The slow solubility of novesthene, in the tissue secretions, prolongs its anesthetic action for from 10 to 36 hours. Novesthene is also stimulating and promotes healing instead of retarding it as orthoform does.

The severed sensory nerve filaments, following an extraction, are stimulated by food particles, thermal changes and other factors. The afferent impulses are, therefore, carried to the brain, stimulating a certain brain center and thus creating the uncomfortable sensation we call pain. The blood clot when formed temporarily protects these exposed nerve fibers until the clot is reorganized into granulation tissues, thus permanently closing up the wound. But until such time that the blood clot is formed, artificial protection is frequently necessary. Novesthene, either in the powder or paste form (novesthol), will anesthetize and protect the severed sensory nerve fibers and assure comfort to the patient, for the time being, until the blood clot or the organized cicatricial tissues can perform their function, affording protection to injured tissue. In a lower socket, the powdered novesthene may be placed directly into the wound, it having been dried previously with iodoform gauze or sterile cotton. A large spoon shaped curette may be used for introducing the powder into the socket, gently packing it down in the bottom of the socket with sterile cotton. The entire socket may be filled in this manner with novesthene and the patient dismissed. In an upper socket, the application of the powder is not an easy task, and here the paste is particularly handy.

The novesthene is gradually absorbed without any residue being left. It is tolerated by delicate tissues without giving rise to any irritation. Being non-toxic, novesthene may be used freely.

Another anesthetic of the same group which may be used similarly is orthoform. The disadvantage of the use of orthoform, however, is its tendency to produce irritation and subsequent sloughing of the tissue.

Should the operation be followed by restlessness, nervous exhaustion and sleeplessness, bromural may be administered. Two five-grain tablets taken internally just before retiring will induce sound sleep without subsequent depression.

In severe cases of pain, a more powerful sedative should be administered, such as chloral hydrate in doses of about 5 or 10 grains of morphine in 1/6 gr. doses.

Validol may also be used to combat postoperative pain, particularly when accompanied by hysteria and nervous exhaustion. Ten drops in a little water may be given internally in such cases.

CHAPTER XIV.

RELATIVE TOXICITY OF LOCAL ANESTHETICS.

With the advent of many synthetic substitutes for cocain, the question arises as to their ratio of toxicity. Cocain has lost its popularity on account of its comparative toxicity. The anesthetist in selecting his local anesthetic, should do so with a full understanding of its toxic index so that he may be on his guard and be prepared for emergencies that may arise. It should be remembered that no local anesthetic is absolutely safe and none are to be used freely without caution. It is true that many thousands of injections are made without the slightest toxic manifestation, but this should not lull the anesthetist into a feeling of absolute security or throw him off his defensive. On the contrary, he should be prepared at all times for any emergency that may arise and thus make the use of local anesthetics safer.

To determine the relative toxicity, tests upon animals are performed in the laboratory. Rabbits, cats, albino rats and guinea pigs are generally selected for this purpose. The anesthetic solution, in a given concentration, is injected at a certain rate per minute. The usual quantity injected is 5 cc. per minute. This is continued until the lethal dose is reached. The total quantity of the solution injected up to the death of the animal is divided by the weight and thus a toxic index is obtained which is expressed in cubic centimeters per kilo of the animal weight. The toxicity ratio is compared to that of cocain.

Fig. 190 shows the relative toxicity of the various local anesthetics when injected intravenously. Fatal doses are given in milligrams of the actual drug per kilogram of the weight of the animal. The range of concentration of the solution of the various anesthetics is also given. It will be observed from this chart that procaine is lowest in toxicity index, alypin the highest, while cocain occupies an intermediate position. Apothesin is almost twice as toxic as procaine. The chart is from a report of the Department of Pharmacology, Cornell University, Medical College, submitted by Cary Eggleston and Robert A. Hatcher. It appeared in the *Journal of Pharmacology and Experimental Therapeutics* in August, 1919, under the title of "A Further Contribution to the Pharmacology of the Local Anesthetics."

It has also been determined by these experiments that the various local anesthetics are mutually and quantitatively synergistic in so far as their toxicity is concerned. If two or more local anesthetics are combined and injected intravenously the symptoms produced will be characteristic of their combined toxic effect. For instance, by injecting 40 per cent of the fatal dose of procaine together with 60 per cent of the fatal dose of cocain, the two representing 100 per cent of the fatal dose, death of the animal will follow.

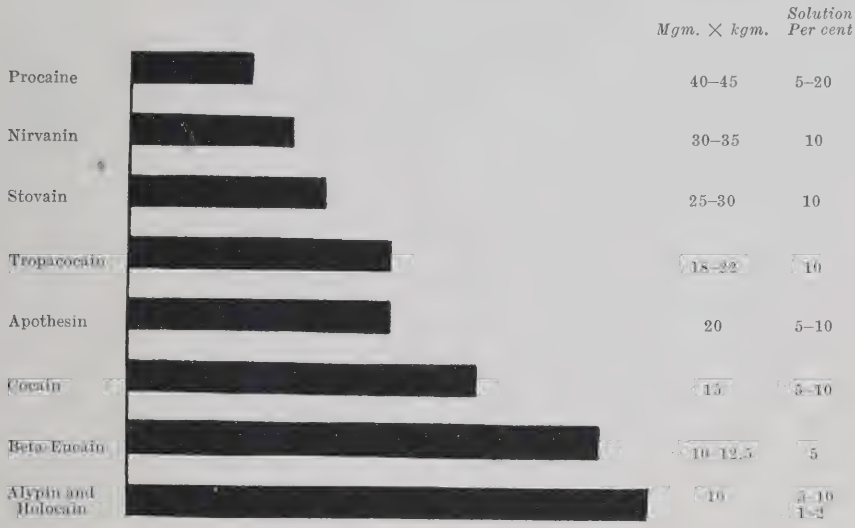


FIG. 190. Table showing relative toxicity, fatal doses in milligrams per kilogram, and range of concentration of solutions (Cary Eggleston and Robert A. Hatcher).

It has been definitely established that by slow or repeated injections a greater amount than the minimal toxic dose may be injected without endangering the life of the animal. This is largely due to the destruction of the anesthetic, in intravenous injections, by the liver. This particularly applies to procaine, and it has been shown that many times the minimal fatal dose of procaine may be slowly injected intravenously without danger to the patient. The action of cocain, however, is cumulative and slow injections of cocain, or when given at intervals, produce increasing severity of symptoms. Holocain acts similarly to cocain. The elimination of these two drugs is a slow process and may not be entirely complete even after a period of one or two days. The elimination of procaine is very rapid and in sublethal doses is completed in a few minutes following the intravenous injection.

Dr. Tompkins' Report.

Dr. H. E. Tompkins, more recently, has undertaken a series of experiments on rabbits and guinea pigs to determine the relative toxicity of local anesthetics, and particularly those which were recently introduced. He found butyn to be more than twice as toxic as cocain.

The following are his findings from intravenous injection into the ear of rabbits, solutions in strength of 0.5% were used and injected at the rate of 5 mils (cc.) per minute. Eight animals were used for each drug. Approximate average indices are:

Butyn	0.3 mil per kilo
Cocain	0.7 mil per kilo
Procaine (with epinephrin 1:40000)	6.5 mil per kilo
Procaine	6.8 mil per kilo
Salicain	42.0 mil per kilo

Guinea pigs; intraperitoneal injections; solution in strength of 1%; rate of injection, 5 mils per minute; 8 animals per drug. Approximate average indices are:

Butyn	3 mils per kilo
Cocain	8 mils per kilo
Procaine (epinephrin, 1:40000)	52 mils per kilo
Procaine	58 mils per kilo
Salicain	335 mils per kilo

These tables give us the following relative toxic indices as compared to cocain.

Butyn is 2 (plus) times *more* toxic than cocain.

Procaine is 7 (minus) times *less* toxic than cocain.

Salicain is 42 times *less* toxic than cocain.

In so far as the clinical application of the two new anesthetics, butyn and salicain is concerned, the writer would like to quote the following from the report of Dr. Tompkins:

> "On undertaking the clinical experiments, the writer determined to use 1% butyn solution in 100 cases, quantity of solution to be used in each case was 2 mils (cc.). On case 42 he stopped and would go no further. Up to that time four manifestations of toxicity had appeared. Case 42, a mandibular block injection, developed alarming symptoms one minute after the injection was started when less than 1 mil of solution had been placed.

This case led to the conclusion that further experimenting would not be wise.

"In fairness to the product, it must be said that the action of butyn was very prompt, very efficient and of greater duration than equal injections of procaine. In fact, were it not for its great toxicity, butyn would be the best local anesthetic in existence, even better in many cases than cocain.

"A summary of the results of the experimental use of salicain is given below. The marvelous freedom from toxicity of the drug, induced the writer to try his very best to produce a psychological anesthesia, if not a physiological effect, with the following results:
Salicain, 2%—plain—dissolved in Ringer solution (0.5%), 10 cases, block injections at mandibular, tuberosity, anterior palatine foramen and posterior palatine foramen. All failed.
Salicain, 2% with epinephrin (1:40000) $MgSO_4$ (10 grs. to the ounce) in Ringer solution. Same as above.
Salicain, 4%, same mixtures as above, 5 cases each, same results.
Salicain, 6%, same mixtures as above, 5 cases each, perfect anesthesia in palatine areas after five minutes, other attempts failed.

"In all cases, except the palatine areas, a deceptive 'pins and needles' sensation obtained at the nerve terminals, thus proving the proper application of the drug. After 30 minutes of waiting, and testing at 2-minute intervals, anesthesia did not appear. Hyperesthesia did appear in 46 cases.

"In palatine areas, anesthesia appeared in about five minutes and persisted for from 2 to 6 hours, but only when the 6% solution was used.

"Three cases were injected in dental areas, maxillary, by infiltration methods. Perfect anesthesia resulted in the soft tissue but none in bony areas, that is, within the bone shell, evidently due to lack of diffusion or osmosis despite the fact that the solution was injected under periosteum.

"Tried three injections, subcutaneous in arm, on myself. Anesthesia, with a 4% solution, appeared at once. The anesthetic area was circumscribed and localized to the site of the injection only. Absolutely no diffusion obtained. A hyperesthetic ring of about 3 or 4 mm. developed around the site injected. Anesthesia at the site persisted for 14 hours. The 'bulge' of the injection (only five drops were injected each time) persisted for 36 hours, but did not completely disappear for nearly three months.

"So we have here an anomaly. Prof. Hirschfelder's laboratory experiments prove salicain to be a good anesthetic. My laboratory experiments prove it to be a perfectly safe anesthetic and my clinical experiments prove it to be almost useless as an anesthetic.

"The conclusions are, then;

Salicain is a perfectly safe but inefficient anesthetic.

Butyn is a very dangerous but highly efficient anesthetic.

Procaine appears to be the safest and, at once, the most efficient local anesthetic for dental use."

CHAPTER XV

QUESTIONS AND ANSWERS.

Frequently, the writer is asked questions pertaining to nerve blocking injections and particularly their postinjection complications. It has occurred to him to publish some of these questions and their answers for the benefit of those brother practitioners who may have had similar experiences and also for the benefit of those who desire to profit by the experience and mistakes of others. The letters of inquiry are not printed in full, but the substance of the letter is condensed to the form of a question, or only that part of the letter is used which deals with the case. The names of the writers are withheld.

Question 1.

"I injected a 2% solution for a girl about 20 years old for the extraction of a bad lower left third molar tooth. Complete anesthesia in fifteen minutes. Used elevator to remove tooth and roots were curved toward angle of jaw bone. Next day patient came back. There was no swelling, no false ankylosis, no soreness whatsoever, but part of the lip was still dead. On the fourth day a tingling sensation occurred for half an hour and left again. This condition has been the same for the past six days. What would cause this condition?"

Answer.

The case described here is quite typical and may be due to either of two causes. 1—Injection of alcohol. 2—Injury to the inferior dental nerve.

Alcohol, when injected, will unduly prolong the anesthesia. Care should be taken therefore to remove all traces of alcohol from the syringe before drawing into it the anesthetic solution.

The mandibular canal is often perilously near the apices of the lower molar teeth, or it may be reached by infection breaking down the bony structure between the apices of molar teeth and the mandibular canal. In such cases the removal of a lower molar tooth or the curettement of the socket may be accompanied by severance of the inferior dental nerve. Prolonged anesthesia will thus be established, as a result of which there is loss of sensation in the lip.

The prognosis in such cases is very favorable. Regeneration of the inferior dental nerve finally takes place and sensation gradually returns. The time it takes for complete recovery depends entirely upon the extent of injury to the nerve tissue and may last from a few weeks to several months. The tingling sensation in the lip described in the letter may be due to the process of regeneration taking place.

Question 2.

"About a month ago I removed an unerupted and impacted first lower bicuspid tooth on the right side. I gave the patient a mandibular injection on the same side and a mental injection on the left side. Numbness of the lip followed and still persists. Kindly advise me wherein I erred in my technique."

Answer.

It is quite evident that this case is similar to the one described above. While the effect is the same, yet the injury is somewhat different. In this case the mental nerve was injured and not the inferior dental as in the other case. In either case, the condition was not due to faulty injection, but to the operative procedure.

Question 3.

"A very peculiar and distressing accident occurred to one of my patients a week ago. I made an infraorbital injection and obtained beautiful anesthesia. I extracted the roots of the lateral and canine and two bicuspid teeth. But to my great surprise anesthesia of the upper lip and the side of nose on the same side persists since the operation. Can you tell me what I have done and how I can remedy this condition?"

Answer.

Prolonged anesthesia of the upper lip and side of nose following an infraorbital injection is of comparatively rare occurrence. It is primarily due to the injection and not to the operation. The only plausible explanation one can give, if we eliminate the possibility of an alcohol injection, is injury with the point of the needle to the infraorbital nerve before its division into the nasal, palpebral and orbital branches. Thus all afferent impulses from the lip and nose are blocked at the point of injury. When making an infraorbital injection, care should be exercised not to strike the under surface of the infraorbital ridge too forcibly with the point of the needle. This caution obtains not only for an infraorbital but for all injections.

The prognosis in this case is just as favorable as in cases of prolonged anesthesia in the mandible. Regeneration gradually takes place. Note:— In this particular patient anesthesia persisted for several months, when sensation finally returned.

Question 4.

"Will you be kind enough to let me know what causes the numbness of the tongue following a mandibular injection? I removed a badly broken down lower second molar tooth, using both elevators and forceps. I gave a mandibular injection and the operation was entirely painless, although it took me about ten minutes to remove the badly broken down roots. Today is the tenth day after the extraction but the tongue is still numb on that side."

Answer.

Unquestionably, there was an injury to the lingual nerve either during the injection or the operation. There is a very remote possibility of encountering the lingual nerve with the point of the needle in making a lingual injection, if the needle be inserted incorrectly too far toward the median line. The most likely and frequent cause is injury to the lingual nerve during the extraction of a lower molar tooth. The course of the nerve toward the tongue is on the lingual alveolar plate, slightly above the level of the apices of the second and third lower molar teeth. During the extraction of these teeth, the lingual alveolar plate and with it the lingual nerve may be injured, thus resulting in prolonged anesthesia of the tongue until union of the severed parts takes place. For this reason, in removing a lower molar tooth, force should be applied toward the buccal alveolar plate instead of the lingual.

Question 5.

"A young lady about twenty years of age presented herself with very sensitive dentine. A mandibular injection was used and 4 cc. of a 2% solution were slowly injected. In a few moments syncope followed with a great contraction of muscles. A physician next door came in who advised using chloroform to cause a relaxation of same. Patient gradually regained her normal self and went home but did not fully return to her former condition until several days later. The physician found later that she was suffering from goiter, infected tonsils and high pulse rate. The patient's mother previously had had several teeth extracted by another dentist (by infiltration) and exhibited about the same symptoms. I might also add that the same afternoon I used conduction without any ill effects on three different people."

Answer.

Patients suffering from some disturbances of the glands of internal secretion are prone to be susceptible to toxic effect of injected local anesthetics in doses which would not affect a normal individual. This is especially true in cases of exophthalmic goiter. In such patients caution is necessary. It is advisable to use a solution containing as little of the pressor principle of the suprarenal gland as possible. Procaine tablets No. 2 should be used in preference to the No. 1, as they contain less than half the quantity of supranol. In extreme cases supranol should be entirely eliminated by using the procaine tablet No. 4.

Note:—The patient in this case had an enlarged thyroid and therefore should be suspected to be intolerant to procaine injection. From the history, it appears to be a family trait.

To eliminate as much as possible toxic disturbances from the injection of local anesthetics the following three rules should be strictly adhered to:

1. Slow injections. Take one minute to inject a 2 cc. syringeful.
2. Have the patient in a comfortable semi-reclining position during the injection.
3. Before injecting and when the point of the needle is in position, draw the plunger slightly back to determine if a blood vessel has been entered.

Treatment.

Administer about ten drops of camphorated validol or a teaspoonful of aromatic spirits of ammonia. In severe cases give hypodermic injection of strychnine, or an intravenous or intramuscular injection of 1 cc. of pituitary extract. Place the patient flat on a couch or on the floor. In very severe cases artificial respiration should be resorted to.

Question 6.

"What is status lymphaticus? How can it be recognized and what relation has this condition to the administration of anesthetics?"

Answer.

Status lymphaticus may be defined as a condition in which all the lymphatic system, the thymus, the spleen and the bone marrow are increased in size and in excessive formation, or are hyperplastic. According to various writers, this condition is more prone to be present in children than in adults. It is difficult to diagnose this condition in the patient, but it is easily recognized in autopsy. The dentist is thus at a disadvantage in not being able to recognize a case of status lymphaticus and thus be on his guard.

When status lymphaticus is present, death may result from the slightest and most trivial causes. There are cases on record where death ensued from such causes as sudden change in temperature, application of a mild ointment in the treatment of eczema, the injection of a few drops of an anesthetic solution, etc. It is stated by some writers that fully 50% of deaths from administration of anesthetics, both local and general, have been caused by lymphatism.

Question 7.

"Patient, male, age 37. Made a mandibular injection for the removal of lower first and second molar tooth on right side. Waited half hour, numbness of tongue pronounced, but anesthesia very slight and there was considerable pain upon extraction of the teeth. Patient unable to smile and unable to lower the lip on that side."

Answer.

The needle in this injection was permitted to glide past the sulcus and into the parotid gland. The cervicofacial branch of the facial nerve was thus anesthetized, so that the motor nerve supply of the lip was blocked. This accounts for the patient being unable to smile. The lack of anesthesia may be explained by the deposition of the solution into the parotid gland and some distance away from the inferior dental nerve. Some of the solution may have reached the inferior dental nerve by diffusion but not in sufficient quantity to fully anesthetize it. The lingual nerve was evidently anesthetized as the symptoms would indicate.

Question 8.

"What may be the cause of the patient being unable to close her lower eyelid after a mandibular injection?"

Answer.

This case is analogous to the preceding one. The anesthetic solution was deposited too far back into the parotid gland. In this instance, however, the injection was also made too high. The cervicotemporal branch of the facial nerve, which serves the lower eyelid with motor nerve supply, was anesthetized. This accounts for the fact that the patient could not close her eyelid on the side of the injection.

Question 9.

"Why do I get soreness following mandibular injections? I am quite sure I use the right technique and do not inject unless the needle strikes bone. I feel that I am, therefore, injecting at the mandibular sulcus. I want to add that I always obtain profound anesthesia."

Answer.

It is quite possible to inject the solution at the proper place and yet not carry out the correct technique. It is possible to obtain profound anesthesia and yet produce soreness and after-pain. This is the way it happens: The needle may be inserted too far toward the median line and thus the internal pterygoid muscle entered. It may then be directed toward the ramus and the mandibular sulcus encountered, but in so doing the internal pterygoid muscle is once more penetrated and traumatized. But what is still worse, the internal lateral ligament is often encountered in this wrong insertion of the needle. Thus, while the actual injection for the inferior dental nerve was correctly made, yet the needle did not travel in the pterygomandibular space but through muscle tissue and ligament. Hence, good anesthesia, but soreness following the injection.

Question 10.

"How can I prevent the breaking of needle in conduction injections?"

Answer.

The breaking of needles cannot be absolutely prevented. Accidents will sometimes happen. But chances of breakage can be reduced to a negligible minimum and the danger of the broken portion of the needle remaining in the tissues almost entirely eliminated. The following rules should be rigidly enforced:

1—There should be no resistance to the injection of the solution in nerve blocking injections.
2—Do not exert any force on the needle.
3—Do not permit your needle to be engaged by the periosteum in nerve blocking injections.
4—Do not bend your needle in the process of injection.
5—Use a long enough needle, so that there will always be sufficient safety margin left, not embedded in the tissues, to engage and remove the needle.
6—Use at least a 42 mm. 21 gauge needle in all nerve blocking injections, except the posterior palatine and incisive.

Question 11.

"Why do some of my patients become nauseous after a mandibular injection with a tendency to fainting?"

Answer.

If the solution employed is to be eliminated, the possibility is that the posterior facial vein has been entered and the solution injected therein. By encountering the mandibular sulcus before making the injection, this contingency may be avoided. Before injecting, a test by aspiration would determine if the needle is in a blood vessel.

Question 12.

"What causes blanching of the skin in conduction anesthesia, frequently at some point distant from the point of injection?"

Answer.

This condition is undoubtedly caused by the injection into a blood vessel. The supranol in the solution causes the contraction of the muscle coat of the blood vessel, which is characterized by ischemia or local and temporary deficiency in blood in that particular area.

Question 13.

"What causes a large swelling in the side of the face following a tuberosity injection?"

Answer.

The needle should be in contact with the tuberosity and not more than one inch length inserted. If it is inserted too far and away from the tuberosity the pterygoid plexus of veins may be entered, causing a venous exudation. The infiltration of the surrounding tissues by the exudates is responsible for the swelling.

Question 14.

"Why do I so frequently fail to get anesthesia in an anterior infraorbital injection?"

Answer.

The most frequent cause is infiltration of the canine fossa and failure to carry the solution high enough to reach the anterior superior alveolar nerve.

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